INSECT LIFE

A MANUAL

FOR THE USE OF SCOUTS IN FULFILLING THE REQUIREMENTS FOR THE INSECT LIFE MERIT BADGE AND FOR ALL STUDENTS OF INSECT LIFE

By

SCOUTMASTER J. CHESTER BRADLEY, M.S., PH.D.

PROFESSOR OF ENTOMOLOGY AND CURATOR OF INVERTEBRATE ZOOLOGY IN CORNELL UNIVERSITY

and

E. L. PALMER, M.A., PH.D.

SPECIAL FIELD SCOUT COMMISSIONER AND PROFESSOR OF RURAL EDUCATION IN CHARGE OF NATURE STUDY IN CORNELL UNIVERSITY

CHICAGO PUBLIC LIBRARY
JAN 1942
DISCARDED

CHICAGO PUBLIC LIBRARY

NEW YORK
THE BOY SCOUTS OF AMERICA
JUNE, 1925

BRANCH LIBRARY
No. 50
C. P. L.

Y 357

(*Copyright* 1925)
by
BOY SCOUTS OF AMERICA
200 Fifth Avenue, New York

422883
4 16 28

PREFACE

In offering to the boys of America this Manual for the study Insect Life, the Editorial Board initiates a departure from the usual form and scope of the Merit Badge Pamphlets.

It has long been the desire of the Board to enlarge the scope of these pamphlets, making them include so comprehensive a study of the subjects involved, that a complete set of these manuals would form a unique and valuable working library for boys.

The valued co-operation of Dr. J. Chester Bradley, Professor of Entomology and Curator of Invertebrate Zoology in Cornell University, and Dr. E. L. Palmer, Professor of Rural Education in Charge of Nature Study in Cornell University, have made it possible to open the contemplated new series with the present Manual on Insect Life.

Both Dr. Bradley and Dr. Palmer add to their distinguished scientific attainments, a keen understanding of boys, and practical experience in working with boy scouts. The book, while meeting the most exacting demands of the teacher or student, constantly intrigues the interest through the humorous marginal gloss, the number and variety of the illustrations, and the style of the text, manages to sustain a delightful informality absent from most scientific books.

This Manual is offered in the belief that it will be of practical help not only to boy scouts, but to all students of insect life.

The editors wish to express to Dr. Bradley and Dr. Palmer their appreciation of this signal service to American Youth.

WILLIAM D. MURRAY
FRANK PRESBREY
HENRY VAN DYKE
Editorial Board

E. S. MARTIN,
Secretary.

REQUIREMENTS FOR A MERIT BADGE IN INSECT LIFE

I. The candidate shall go into the country with the examiner* and show to him the natural surroundings in which certain specified insects live, and shall find and demonstrate living specimens of the insects, telling something of their habits, or of the nature of their fitness for life in their particular surroundings. The examiner shall ask for an insect from each of five of the following groups without forewarning to the candidate, but the scout shall have the choice of kind within each group.

1. (a) May-fly nymphs, (b) caddis-worms, (c) ant-lion larvae (doodle-bugs), (d) velvet-ants.
2. Larvae and pupae of mosquitoes.
** 3. (a) Centipedes, (b) scorpions, (c) orb-weaver spiders.
4. (a) Scale-insects, (b) plant-lice.
5. (a) The nest of a solitary bee or wasp and its maker (mud-daubers excluded), (b) bumble-bees and their nest.
6. (a) Back-swimmers, (b) whirligig beetles (demonstrate a peculiarity of their eyesight), (c) water-striders.
7. (a) Carrion-beetles, (b) tumble-bugs, (c) leaf-beetles.
8. (a) Colony of carpenter-ants, or (b) of agricultural ants, (c) black-fly larvae, (d) white-ants.
9. (a) Crane-flies, (b) robber-flies, (c) damsel-flies and their nymphs.
10. Caterpillar of: (a) cabbage-butterfly, (b) alfalfa-butterfly, (c) monarch, (d) sphinx; (e) tiger-beetles.

*While it is desirable that whenever practicable this test shall be given in the field, as indicated above, it is realized that there will be some instances where to so require would be a hardship. In such cases the test may be given indoors and the examiner shall give the scout advance notice of the groups from which he is to bring specimens. The scout shall bring fresh material (preferably living) of the species selected, and shall describe the conditions under which he found them, telling something of their habits, or of the nature of their fitness for life in those particular surroundings. It is not necessary that this test should be completed in a single day, but the examiner should satisfy himself that the scout knows from first hand experience at least one kind of insect in each of the twelve groups, and is not simply primed on the five selected groups.

**These near relatives of insects are included in the insect life merit badge requirements as a matter of convenience, and in compliance with the common custom of extending the term entomology to include the study of the close relatives of insects.

11. (a) Grouse-locusts, (b) meadow-grasshoppers, (c) katydids.

12. (a) Squash-bugs, (b) chinch-bugs, (c) larvae of gall-wasps and their galls, (d) other kinds of gall-insects or their galls.

II. Make an artificial ants' nest suitable for observation and maintain a colony of ants for a period of at least two weeks. Make a record of interesting facts and habits observed. Or do the same with an observation hive of bees.

III. Make a collection of fifty species of insects. This collection will be judged upon 4 points: (1) correctness of names; (2) neatness of arrangement; (3) perfect condition of the specimens (clean, unbroken and properly mounted); (4) adherence to the following rules:

(a) It is desirable that each species be represented by two male and two female specimens when specimens can be readily found and the sexes easily distinguished.

(b) A neat written or typewritten label stating the name of the species (either common name or scientific or both) to be pinned on the left of or above the row of specimens of each species.

(c) The species of each family and order to be arranged together; the sequence of orders and families to be that followed in a text-book; the scientific name of each to be indicated by appropriate labels.

(d) Entomological pins to be used when obtainable instead of common pins.

IV. Give evidence that he has bred through all its life stages from egg or young larva to adult at least one species of insect. Mosquitoes, blow-flies, cabbage-butterflies, and ants are suggested as easy species to rear.

ACKNOWLEDGEMENTS

The authors wish to acknowledge their indebtedness to the following firms for permission to include the copyrighted cuts indicated: MacMillan and Co. (Figs. 19, 20, 23, 24, 39, 40, 41, 43, 44, 45, 46, 47, 48, 49, 114, 115, 130, 134, 137, 138, 144, 154, 155. We are requested to especially call attention to the fact that these are copyrighted and not to be reproduced); G. P. Putnam's Sons (Fig. 68); P. Blakiston & Son (Figs. 71, 84; Fig. 4 is redrawn from figures in Folsom's Entomology); Nature Publishing Co. (Figs. 29, 30, 33, 34, 35, 36, 68, 118, 120, 121, 122, 123, 124, 126, 127, 128, 143, 145, 146, 148, 150, 151); Comstock Publishing Co. (From Comstock's Manual: Figs. 11, 22, 26, 54, 64, 65, 66, 70, 105, 107, 111, 113, 116, 117, 119, 125, 131, 153; From Mrs. Comstock's Handbook of nature study, Figs. 18, 69; From Needham & Lloyd's Life of inland waters, Fig. 396. Of most of these duplicate or original cuts were loaned us); American Museum of Natural History (Figs. 73 to 81, inclusive). To Dr. Wm. A. Riley we are indebted for the loan of cuts of the following figures, mostly from the publications of Otto Lugger: 27, 31, 112, 135. To the New York State College of Forestry we are indebted for the loan of a cut of Cyllene, from which Fig. 152 was prepared. The following figures are taken from various publications of the U. S. Department of Agriculture: 14, 15, 16, 17, 38, 52, 55, 59, 60, 72. The following are from Bulletin 67 of the U. S. National Museum, mostly after the author, Mr. Nathan Banks: 32, 37, 41, 42, 51, 53, 67, 83, 96, 101, 102, 106, 108, 109, 110, 129, 132, 135, 136, 140, 141, 142, 147, 149. The following figures are from the insects of New Jersey, by John B. Smith: 7, 8, 9, 50, 56, 58. Fig. 133 is redrawn after Hungerford. Fig. 2 is redrawn from O. H. Latter, The natural history of some common animals. Fig. 21 was drawn from a photograph published in a translation of a volume of Fabre (See bibliography item No. 27).

We are further indebted to MacMillan & Co. for permission to make certain quotations from their published works; to Mrs. Comstock for permission to quote freely from her publications; to Professor G. W. Herrick for a statement concerning the extent of damage done by injurious insects, and to all other persons upon whose publications we may have drawn for statements or facts related.

The authors disclaim originality in this work. It has been our aim to select, mostly from already published material, that which will be useful to scouts in preparation for the insect-life merit badge, and where we have found suitable material, we have not hesitated to quote even the exact wording of the author, or in other cases, to rewrite it for the particular readers for whom this work is prepared.

J. CHESTER BRADLEY.
E. L. PALMER.

CORNELL UNIVERSITY,
ITHACA, N. Y.
June 1, 1925

CONTENTS

CHAPTER III.

KEEPING SOCIAL INSECTS UNDER OBSERVATION. REQUIREMENT NUMBER TWO.

CHAPTER IV.

MAKING A COLLECTION OF INSECTS. REQUIREMENT NUMBER THREE.

CHAPTER V.

REARING AN INSECT. REQUIREMENT NUMBER FOUR.

CHAPTER VI.

About Entomology as a Profession and Entomologists

CHAPTER VII.

CHAPTER VIII.

Bibliography

APPENDIX A.

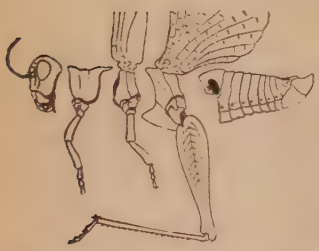
APPENDIX B.

CHAPTER 1

BY WAY OF INTRODUCTION

At the start, let's get straight on some important points about insects in general.

THE PARTS OF AN INSECT



Spread the wings of a grasshopper, or beetle, and you will see that it, like all adult insects, is made of three distinct parts, the head, thorax and abdomen.

The thorax is the central part, and may always be told because it is the part that bears the legs and wings. It is made up in turn of three more or less ring-like pieces which are closely welded together, the prothorax, mesothorax and metathorax (which mean, respectively, the front thorax, middle thorax and hind thorax). The prothorax bears the front legs but no wings, the mesothorax bears the middle legs and front wings (forewings) or in the case of beetles and grasshoppers, the wing-covers, and the metathorax bears the hind wings and hind legs.

Chesty chaps

In front of the thorax, and attached to it by a thin, though usually very short neck, is the bead-like head. On each side of it is a large black eye, composed of many tiny facets, and from the front or sides project two organs very characteristic of all true insects, the feelers or antennae. With them the insect feels and explores its surroundings, and also smells with them, so that like the antennae of a wireless station, they quite truly

Bullet heads

Antennae receiver

receive and carry to its brain messages from the outside world in which it lives. At the bottom of the head is the mouth, with some complicated chewing and tasting structures, most important of which are the heavy biting jaws. All insects do not have these, however.

A funny tummy!

The third part, or abdomen, behind the thorax, is made up of several rings, fitted one over another. It never bears legs or wings.

In caterpillars and many young insects, these three body parts are not so easily distinguished, although they really are there.

THE GROWTH OF INSECTS

When an insect hatches from the egg it begins to eat and grow and as long as it is growing it has no wings. It is in the boyhood of its existence, when eating and growing are the two main things of its life. A boy grows gradually from day to day, and his skin grows with him, but an insect can't show its growth at all as long as its skin stays on its back, for the skin is hard and can not stretch. So the insect keeps growing inside its skin until it is so tight that the skin splits down its back, and Mr. Bug crawls right out of its own skin. It is clothed, however, in a new skin which has formed under-

Growing out of its skin

Fig. 2—*A dragon-fly crawling out from the skin of its nymph (young)*

neath and is still soft and can stretch a whole lot before it hardens, to accommodate the new growth of the creature. By and by this skin also hardens, and then there is no more growth until it in turn is split and shed. This casting of skins is called molting, and the translucent empty ghost-like skins of some kinds are often found. Nearly every one has found the cast skins of cicadas (locusts) on tree trunks, and of dragon-flies, stone-flies and may-flies on stems or stones near the water's edge, or floating on the water.

The change of form from the baby wingless insect to the adult winged insect may be little or great, according to the kind of insect. It is called metamorphosis, which means simply "change." The baby grasshopper looks like a wingless edition of its parents. The second time it sheds

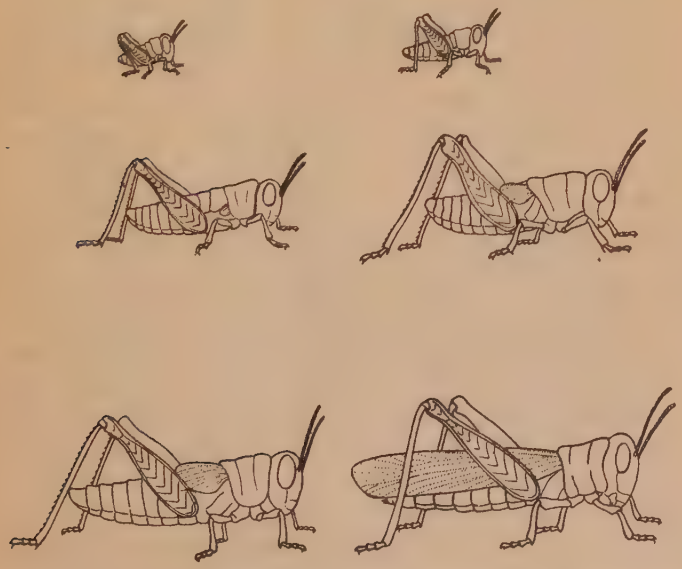


Fig. 3—*Successive growth stages of a grasshopper, from just-hatched to adult, illustrating incomplete metamorphosis*

its skin, one may see by looking closely, little rounded pads attached to the back of the mesothorax and metathorax; these are the beginnings of the growth of the wings; they are shown in figure 3. Each of the next two times the young grasshopper molts these wing-pads become larger, but are still very far from being wings when the creature is ready for the fifth and last molt. Each time it has molted the young grasshopper has become more and more like its parent. When it sheds its fifth skin it has completed its growth and become adult. The wing-pads have grown into perfect wings and wing-covers; the insects are ready to mate, and the females to lay eggs. This is the grown-up stage of their life, and although like men and women they continue to eat, they never again increase in size or shed their skin.

Growing up

The boy stage of a butterfly is a caterpillar, and its growth is different from that of a grasshopper. After it leaves the egg, it, too, has nothing to do but to eat and grow, and it also grows by shedding its skin from time to time. But the caterpillar in no way resembles its parent, the butterfly. When it changes its skin it grows in size, but does not become any more butterfly-like. It remains a caterpillar and has no trace of wings. By and by it will have eaten all that it requires and be ready for the last molt. When it sheds its skin this time, instead of a new and larger caterpillar coming out, there will appear a totally different, mouthless, legless, almost motionless creature, the chrysalis. Sometimes the chrysalis is hidden by having had spun around it for protection a cocoon of silk, but if you open the cocoon you will find the chrysalis inside. This chrysalis is neither caterpillar nor butterfly, but is a between-stage. While it is a chrysalis, the creature neither eats nor moves around (although it breathes) but rests while

Would never know their own kids

Mummy

Fig. 4—*Monarch caterpillar changing to a chrysalis, and the chrysalis to a butterfly, illustrating complete metamorphosis*

Nothing to do but rest

the organs of its caterpillar body are being made over into the new organs of the butterfly. When this has been done, the shell of the chrysalis also splits down the back and out crawls a fragile delicate creature, with soft crumpled wings, which quickly expand and harden in the air and light, and soon it flies away a perfect butterfly. It too has gained its wings in this adult stage, and from now on will never grow nor molt again. It will feed but little, if at all, but will mate, the females will lay eggs, and before long they will die.

Lacking something

Insects that grow like grasshoppers are said to have an incomplete metamorphosis. Their young stages are called nymphs. Squash-bugs and dragon-flies are examples of other insects that grow that way.

But these have it—A pupa. (No, not papa, nor puppy, either)

Insects that grow like the caterpillar are said to have a complete metamorphosis. Besides moths and butterflies, all beetles, flies, wasps, bees, and some others grow that way. The young growing stages are called larvae (singular larva) and the resting stage a pupa (pleural pupae).

GROUPS OF INSECTS

If we are speaking of machinery we classify it in groups. There are many kinds of automobiles but they are all automobiles as distinguished from locomotives, of which there are in turn many kinds. There are many kinds of gasoline engines, and of steam engines, and of alcohol engines, but they are all engines. So in the world of life there exist countless kinds of creatures all of which are butterflies or moths, others which are beetles, others which are flies and so on, but all of these are insects, as compared with spiders or centipedes, or crawfish, which are not insects. The difference is that the groups of machinery are man-made, therefore artificial, while those of animals are the growth of nature,

hence not artificial. Way back, countless aeons before human life came into existence, the forebears of all butterflies and moths or of all beetles, or of all flies were alike. So looking at it in a very great, almost eternity sense, we may say all butterflies and moths, all beetles, or all flies are members of the same great family.

The way it is done

These great groups (butterfly and moth, beetle, fly, etc.) are called by naturalists *orders*, and they in turn are divided into lesser groups called families and these into smaller groups called genera (singular genus). Each genus is composed of *kinds* or species. In giving the name of an insect, naturalists write first the name of of the genus (begun with a capital letter) then the name of the species (with a small initial letter). To illustrate: The genus Cicindela are all tiger-beetles; *Cicindela sexguttata* is a green kind with buff spots; *Cicindela punctulata* is a black kind with pale spots. Different genera of tiger-beetles together form the family Cicindelidae.* All the families of beetles taken together form the order Coleoptera (beetles); all the orders together form the class Insecta (insects).

A bug's calling card

Most insects belong to one of the following seven orders, of each of which there are very many kinds. The scout should recognize the members of at least these orders. In addition there are 19 smaller orders,† for information concerning which see: Comstock: Manual for the Study of Insects, and appendix B to this pamphlet.

* Family names may be recognized by always ending in -idae.

† The smaller orders are: Protura, Thysanura (silver-fish, etc.). Collembola (spring-tails, etc.), Zoraptera, Isoptera (white-ants), Neuroptera, (dobsons, ant-lions, etc.), Ephemerida (may-flies), Odonata (dragon-flies or darning-needles), Plecoptera (stone-flies), Corrodentia (book-lice and bark-lice), Mallophaga (bird-lice), Thysanoptera (thrips), Embiidina, Anoplura (lice), Dermaptera (ear-wigs), Strepsiptera, Mecoptera (scorpion-flies), Trichoptera (caddis-flies), Siphonaptera (fleas).

ORTHOPTERA. *Grasshoppers, crickets, roaches, walking-sticks, and mantids (mule-killers or rear-horses).*

The metamorphosis is incomplete. Therefore the older nymphs have wing-pads, and otherwise resemble the adults. The adults (except in a few wingless kinds) have 4 wings, but the top pair are leathery and serve as wing covers, overlapping on the back, while the much larger membranous hind wings are folded up beneath them like a fan. The mouth has heavy biting jaws.

HEMIPTERA.—*Bugs.*

The metamorphosis is incomplete, the nymph being like the parent but with wing-pads. Except in some wingless forms, the adults have two pairs of wings, and the basal half or more of each forewing is thickened and the extremity of the wing is thinner, the one overlapping the hind part of the other wing. The mouth is a jointed sucking beak, and there are no biting jaws.

HOMOPTERA.—*Cicadas, hoppers, plant-lice, scale-insects.*

The metamorphosis is also incomplete. Except in wingless forms, the adults have two pairs of wings,* alike in texture and held sloping on the back like a roof. The mouth is a tube formed for sucking, and there are no biting jaws.

LEPIDOPTERA.—*Moths and butterflies.*

Metamorphosis complete, the larva a caterpillar, the pupa a chrysalis. Two pairs of wings, covered with microscopic scales, which brush off like dust. Mouth-parts of the adult consisting of a tube for sucking nectar, there being no jaws.

DIPTERA.—*Flies.*

Metamorphosis complete. *One* pair of wings, the place of the hind wings taken by a tiny pair of stalked

* Male scale-insects have only one pair.

knobs (balancers). Mouth fitted for piercing and sucking or lapping, without jaws.

COLEOPTERA.—*Beetles.*

Metamorphosis complete. Really two pairs of wings, but the forewings are shell-like, and form a close fitting cover over the membranous hindwings which are folded up crosswise (not fan-like) beneath them. Mouthparts formed for biting and chewing, with heavy jaws.

HYMENOPTERA.—*Wasps, bees, ants, ichneumon-wasps, gall-wasps, saw-flies and horn-tails.*

Metamorphosis complete. Except in wingless forms there are *two* pairs of membranous wings, fastened together by a number of microscopic hooks along the front edge of the hindwing. The mouth has biting jaws, but sometimes the tongue is developed into a long tube for sucking nectar.

CHAPTER II

THIRTY-SEVEN KINDS OF INSECTS, WHERE AND HOW THEY LIVE

REQUIREMENT NUMBER ONE

The candidates shall go into the country with the examiner and show to him the natural surroundings in which certain specified insects live, and shall find and demonstrate living specimens of the insects, telling something of their habits, or of the nature of their fitness for life in their particular surroundings. The examiner shall ask for an insect from each of five of the following groups without forewarning to the candidate, but the scout shall have the choice of kind within each group:

1 (a) *The nymphs of May-flies.* (Order Ephemerida).

If you live in a region of swiftly flowing streams, turn over some of the stones which are washed in the current. On lifting them out of the water, you will see little flattened creatures with three long thread-like tails scurrying away with a sidelong gait to hide, which perhaps they can only do by running around onto the bottom side whenever you turn the stone over. They are the nymphs* of may-flies of the genus Heptagenia and its allies.

Scuttlers

If you gaze face downward into a still, shallow pool, or rake with a net the aquatic vegetation of such a pool, pond, sluggish stream or ditch and dump the contents into a basin of water, you will at any season of the year see delicate creatures like those figured, resting on the plant stems, or on the bottom, or swimming about with quick jerky movements. They are another type of may-

Water babies

* For meaning of nymph, and distinction between nymph and larva see page 6.

fly nymphs, belonging to such genera as Siphlonurus, or Callibaetis.

Fig. 5—*Nymph of a may-fly, Callibaetis. Greatly enlarged*

Watch the backs of their abdomens. On many segments plates are attached, which they wave in unison, rhythmically in the water. These are gills, and the insect is breathing. It is only by the possession of these that the insect is able to live in water without drowning, for insects are normally air-breathers. The flattened Heptagenias also have these gills. By having gills of this type may-fly nymphs may be told from stone-fly nymphs, which look like the may-fly nymphs that live under stones, and live with them. The stone-fly nymphs have threadlike gills under their thoraces instead of the plates on the sides or backs of their abdomens. Stone-fly nymphs also have only two threadlike tails, while nearly all may-fly nymphs have three.

A deep breath

Two tails or three?

The flattened shape of the Heptagenias is to permit them to cling tightly to the stones and crawl beneath them, without danger of being washed away by the swift currents. These nymphs live from two to three years before becoming adults and molt many times.

Edging beneath the rocks

Fish nets

The mouths of may-fly nymphs are provided with complicated strainers and rakers, for catching or scraping up the microscopic one-celled plants that form their food. Look at the mouth-parts with a lens.

Other larger kinds of may-fly nymphs live in the mud at the bottom of deep rivers and lakes, and countless thousands of their cast skins appear on the surface of the water of large lakes during the early summer. Then the air is filled with myriads of the dancing imagos.

When a may-fly gets its wings it is at first dull colored. It remains so, in what is called the sub-imago stage for a few minutes or a few hours, according to the species, and then it sheds its skin again and for the last time, coming forth in its full bright colors. It is the only kind of insect that sheds its skin again after it gets its wings.

Ghosts

The adult may-fly is the most delicate of winged creatures. It is more like a bit of gossamer than a real insect. It takes no food during its short life, has in fact no mouth. Its buoyancy is increased by the fact that its stomach is filled with air. For a few hours it dances the strange weaving aerial dance of its kind. mates, the females scatter their eggs over the surface of the water, and soon they all are dead.

Air pudding and no mouths

Dance and die

May-flies are common insects in all parts of the United States. The adults are often attracted to lights at night.

1 (*b*) *Caddis-worms.* (Order Trichoptera).

Moving sticks in a pool

Watch quietly the bottom of a clear shallow pool or spring. You are likely to see certain short sticks on the bottom suddenly walk off as though endowed with life. No, they are not walking-sticks, nor swimming-sticks either. In fact they are not exactly sticks at all, and if you watch carefully you will see the head and legs of a sort of caterpillar sticking out of each, and it is these legs that are doing the crawling. Fish out one

of the sticks and pull on the creature by his head and legs, and as soon as you can make him let go with a sort of hook that he has at his tail to hold on with, you can drag him right out, and you will see that the stick is just a hollow case that he is living in. In fact, he is a caddis-worm, and he built that case, bit by bit, by fastening twigs or bits of bark, or weeds, or something else together with silk, and it is his house, and he not only lives in it and builds it bigger as he grows, but he carries it around with him wherever he goes.

Carries house on his back

Fig. 7—*Cases made by caddis-worms*

There are many kinds of caddis-worm cases, each made by a particular kind of caddis-worm. Sticks, pieces of leaf, pebbles, sand grains and shells are the things mostly used in building their cases. The sticks or pieces of leaf may be laid on lengthwise, or in regular spirals, or cross-wise, like a stick chimney. Some kinds build little spiral cases of sand grains that look like snail-shells. Others build fixed tubes among stones in

swift currents, with the open end facing the current. Leading to this opening they spin fine-meshed funnels, nets of silk. Then they lie waiting in their case, jaws ready to seize whatever bit of food chance and the current bring into their trap!

Fish weirs

One of the very commonest kinds of caddis-worms lives under stones in swift streams, building beneath them a little barricade of pebbles, held together by silk. When the stone is lifted this barricade is often torn apart, and the worm exposed, or the case may remain attached to the stone as a little bunch of pebbles and sand grains.

Stone houses

If you will pull the caddis-worm out of its case you will see that it has many little threads attached to the sides of its body. These are gills.

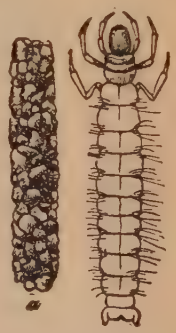


Fig. 8—*A caddis-worm and its case*

Caddis-flies eat mostly vegetable food, but some also occasionally eat tiny insect larvae and the like.

When the caddis-worm is grown, it seeks a secluded place, spins a net over both the front and back entrance to its case, and rests for two or three weeks, becoming quite incapable of walking. Then it changes to a pupa.* The pupae are quiet, except for the rhythmical contraction of their abdomens, keeping a current of water flowing through their cases. Curiously enough they later become able to walk, and with the large jaws with which they are provided, eat their way out of the case and climb up some support out of the water and emerge as adults. They shed their jaws, and as adults take little or no food.

A long nap

Lose a tooth? No, a whole jaw!

* For meaning of pupa see page 6.

Fig. 9—*An adult caddis-fly with its wings spread*

Adult caddis-flies look much like moths. They remain near their places of emergence, and may be found resting on leaves or trees overhanging streams. All slender, black, or pale green or whitish mothlike creatures with very long threadlike antennae held straight in front of them when at rest and found around streams, may be set down as caddis-flies, but there are other kinds not so readily described. Of course, they all lack the scales on their wings that moths possess; but the wings are often very hairy. They are always held folded over the back when at rest, and not spread out as shown in the accompanying figure.

The eggs are laid in masses of gelatine, either in the water or on objects above it.

Caddis-flies live in all parts of North America, wherever there is suitable water. They are very fond of flying about lights at night.

1 (*c*) *Ant-lions or Doodle-bugs.* (Family Myrmeleonidae; order Neuroptera).

Fig 10—*The pit-trap of an ant-lion*

The southern scout needs no introduction to the little pits in sand, shaped like inverted cones, which are the homes of "doodle-bugs." The "doodle-bug" himself is a stubby bristly chap that has a habit of

backing off when uncovered, and rapidly digging into the sand. He has long sickle-like jaws, each one hollow, so that he can use them like a soda-water straw for sucking the juices of his victims. He lies buried in the sand at the bottom of the pit, only his jaws sticking out, and waiting for any insect so out of luck as to fall over the edge of the pit and begin sliding down toward the bottom. If it doesn't slide fast enough, Mr. Doodle Bug uses his flat head like a shovel and flings sand up onto the insect and knocks it down. An ogre? I'll say he is.

Unlucky beggar

Ogre

Fig. 11—*An adult ant-lion, with its young*

When full-grown the doodle-bug makes a little case like a ball of sand by spinning the grains together with silk, then lines this case inside with silk, and rests, sometimes all winter, before changing to a pupa. The adult ant-lion looks like a damsel-fly (darning-needle) but may be told by the stouter hooked antennae, and by the different appearance of the veins around the margins of its wings.

Ant-lions are southern creatures. They are common enough in the south and west and along the Atlantic seaboard to north of New York City; but in the interior that far north, or farther, they are rare or altogether absent.

1 (*d*) *Velvet-Ants or Cow-Killers.* (Family Mutillidae; order Hymenoptera).

These are not ants, but wingless wasps. They may be found running over the ground where it is bare or sandy, and are often brightly colored and often covered

Fig. 12—*A velvet-ant* (*Dasymutilla occidentalis*)

with dense hair, giving them, as their name implies, a velvety appearance. They are always more hairy than ants. They are usually red or orange or yellow and black and silvery. They run quickly about over the ground, with hasty nervous motions, exploring every little cranny and hole. They have very long painful stings, which they can protrude at will, nearly to the length of their abdomen. Catch them between two sticks, and they will squeak. This is not done with a voice, but by rubbing ribbed surfaces over one another. They are always on the search for nests of some kind of bee or wasp, for they do not make their own nest, but lay their eggs in the nests of other wasps or bees.

Pretty but hot!

The males have wings and fly around near the ground in situations frequented by the females. But in the west there are certain kinds of males that are straw colored, without much hair, and that do not appear by day, but fly in numbers to lights at night. They look like large winged ants, but may be distinguished in this way: The first segment of the abdomen of ants forms always a swelling, or sort of knot or scale, connected with the second only by a very narrow constriction, but in velvet-ants it is not so, at least in those which are not densely hairy. Or if the first segment is somewhat knobby it is longer than in ants, and much less deeply constricted from the second.

Can't keep away from the white lights

Velvet-ants are creatures essentially of the south and west, especially of dry and sandy regions where they are very common. They are common along the Atlantic coast north to Cape Cod, but in the northern interior, and in the mountains they are scarce or rare.

2. *The larvae and pupae of mosquitoes.* (Family Culicidæ; order Diptera).

Fill a deep dish 2/3 full of water from a creek or pond, put in a few water weeds and let it stand for several summer days in the open air. By and by you will find floating on the surface things that look like little black chips.

Fig. 13—*The egg-raft of a mosquito*

A boat-load of eggs

A magnifying glass will show that they are bundles of eggs, set upright, side by side, and all connected together to form a sort of little boat. They are the egg-rafts of mosquitoes.

Watch carefully for the eggs to hatch, which is likely to be about noon on a warm day, and may be within as soon as sixteen hours after they are laid. The tiny larvae will issue from the under side, and are very active at birth, wriggling rapidly through the water.

Wrigglers

You now have a fine crop of young "wrigglers" and can watch them through every stage of their life-history, without having to give them any particular care, for they will feed upon the tiny bits of decaying vegetation in the water. It is best, however, to cover the top of the dish with cheese-cloth in order to prevent later the escape of a brood of mosquitoes.

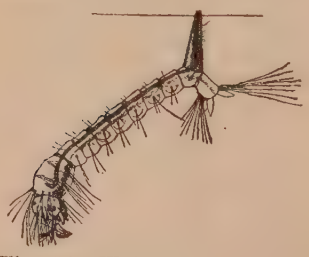


Fig. 14—*Wriggler of common house-mosquito (Culex) hanging to the surface-film*

Coming up for breath

The wriggler cannot breathe water. Once every few minutes, when it needs a breath of air it must swim to the surface, where you will see it stick the long tube that is attached to its tail up through the surface-film. On the tip of this tube is a star-

shaped valve which the wriggler keeps closed when under water, but which it opens when at the surface, permitting the air to enter its body through the tube. When this tube is thrust through the surface-film of the water it keeps the wriggler afloat. When undisturbed the wrigglers congregate at the surface, from which they hang by these tubes, at an angle of 45°, feeding as they hang there. Their jaws are armed with brushes, which they move rapidly, thus setting up little currents in the water which in turn carry food particles to their mouths. Pretty soft snap for them!

Eats while it hangs

Soft snap!

Startle by a sudden movement the wrigglers hanging from the surface. They will close their valves and drop to the bottom. Another tube at the tail end, shorter than the breathing tube, bears four fingers and some hairs; these are the swimming organs. The wriggler swims tail foremost in a series of somersaults.

Swimming

Soon the swarm of baby wrigglers will molt, and the cast skins may be found floating in the water. They molt again, and in about seven days from the time they hatch, or longer if the weather be cool, they are ready to become pupae.

Fig. 15—*Pupa of common house mosquito (Culex)*

Fig. 16—*Pupa of malaria mosquito (Anopheles)*

Curiously enough the pupae, unlike those of other insects, can swim around as actively as the larvae. That is necessary so that they can escape from fish which would like to devour them. But they do not feed. They are mostly thorax and head with a slender tail-like abdomen. They have two trumpet-shaped breathing tubes born at the top of the thorax, and the pupae when undisturbed lie motionless attached by them to the surface-film of the water. They can not sink as readily as the larvae, but descend only by means of violent muscular efforts. They have two flaps at the end of their abdomens with which they swim. The pupal stage lasts two days in hot weather. Then, while at the surface, the skin splits down the back, and the adult works its way out, standing upon its own floating skin, as on a raft. The least breeze may cause a catastrophe at this critical moment, causing the mosquito to drown before its wings are ready to support it. When the adults are emerging, remove some pupae to a butterplate filled with water, and watch this emerging process under a magnifying glass.

Quite a sight

The adult male mosquitoes do not bite, and may be distinguished from the females by the presence of plume-like mouth-parts and antennae. Mosquitoes may be distinguished from midges, crane-flies and other flies that resemble them, by the fact that along the veins and margins of their wings are rows of scales similar to those found on the wings of butterflies.

Fig. 18—*A mosquito-aquarium*

About two weeks before coming up for an examination for a merit badge in entomology, if a scout starts a mosquito-aquarium, he can not only

demonstrate the wrigglers to the examiner, but will be able to show a life-history completed in accordance with requirement number four.

A few years ago it was discovered that certain terrible diseases, such as yellow-fever, malaria, elephantiosis, and dengue-fever were spread only by certain kinds of mosquitoes. The resultant knowledge has led to the almost complete extermination of one of these diseases, yellow-fever, in the western hemisphere, and has made it safe to live in parts of the tropics which formerly were deadly to whites of northern blood. It has further given us knowledge of how to control and take precautions against malaria.

The malaria mosquitoes are those belonging to the genus Anopheles. Its larva may be distinguished from that of the common and harmless house-mosquito of the genus Culex, by the shorter breathing tube, shown in the figure, and by the fact that when at rest beneath the surface-film, they stretch out almost parallel to the surface-film, as shown in the illustration, instead of inclining at an angle of 45° (see figure 14). Differences between the pupae of the two are shown in figures 15 and 16. The adults of the malaria mosquitoes may be recognized from all others by their spotted wings, and by the position they assume when resting, head down and beak and hind legs held outstretched more nearly parallel to the body than in Culex. Adult malaria mosquitoes are night-flyers, and come about only at night, or in the evening, or in dark places, such as darkened cabins and huts, or on dark cloudy days. In many parts of the

Fig. 17—*Wriggler of malaria-mosquito (Anopheles) hanging to the surface-film. Note the angle it assumes*

south, near swamps or streams, they come out at night in countless thousands.

The scout should not suppose that every malaria mosquito that bites will give him malaria. The particular mosquito must have first bitten a malaria patient, a certain number of days previously, because the mosquito transmits the disease, only by first taking into its own system from a malaria infected person or animal, the malaria organism, and this organism must undergo certain changes in the body of the mosquito before it can be again transmitted to a human being.

3 (*a*) *Centipedes, and* (*b*) *scorpions, and* (*c*) *orb-weaver spiders.*

These are not insects. They belong to other classes, the distinctions between which are as follows:

1. Class *Insecta*: *Insects.* *Have six legs, head, thorax and abdomen, usually wings, and the head has a pair of antennae.

2. Class *Arachnida.* *Spiders, scorpions, granddaddies*, etc. Have eight legs, no wings or antennae. There is an abdomen, but the head and thorax are joined in one piece.

3. Class *Chilopoda.* *Centipedes.* There is a head which bears antennae, but the thorax and abdomen are alike and consist of many segments, each bearing *one* pair of legs. No wings.

4. Class *Myriapoda.* *Millipedes.* Like centipedes except that each segment bears *two* pairs of legs.

---

* These characters do not apply to the young of insects with a complete metamorphosis, which are not insect-like in appearance, often lack legs or have apparently more than 6 legs (counting the false legs of caterpillars). The young of spiders, scorpions, centipedes and millipedes closely resemble their parents.

3 (*a*) *Centipedes.* (Class Chilopoda).

If you will pull the bark off of some old logs or look beneath them or beneath some stones, you will frequently see a slender wormlike creature, with very many pairs of legs, which will go scurrying away with so many motions of its legs that you wonder how it keeps them going all at once without getting all mixed up. Press a stick down on it, and if it be one of the very long slender kinds, you will see it go through a series of sinuous motions that would win a professional contortionist fame. The creature is a centipede or hundred-legger, unless it has two pairs of legs on each ringlike segment of the body in which case it is a millipede, or thousand-legger and not the fellow we are after. The millipedes do not move fast, like the centipedes, and just curl up when disturbed.

Gymnasts

Centipedes live on insects, and some kinds especially on earthworms, chasing down an earthworm hole like a ferret in a rabbit hole. They stay hidden for the most part, in cracks and crannies and don't come out into the light. If one keeps them in captivity and watches the egg-laying he may see a curious thing. For some male centipedes are very ill-mannered, and when they see that their wife has laid an egg, they rush up and devour it, unless she can succeed first in rolling it around in the earth and thus making it unpalatable. Really Mr. Centipede, that's carrying things a bit too far!

The rude thing!

Just beneath the mouths of centipedes are great poisonous claws, which in the larger southern species are capable of inflicting a painful sting.

The house-centipede is very common about basements, bathrooms and pantries in the south, but is rather rarely seen in the more northern states. Its very long legs,

which tangle up like a skein of silk when the insect is killed, give it a very curious appearance. It feeds on roaches and other insects. It can give a painful sting, but does so only rarely.

Centipedes live in all parts of North America.

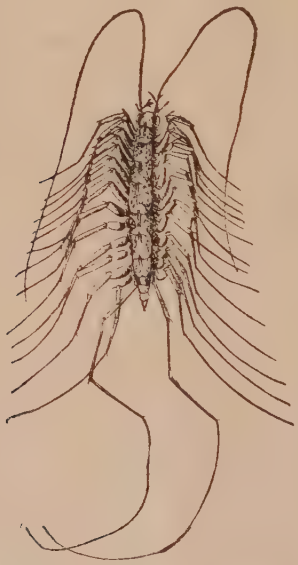


Fig. 20—*A house-centipede*

3 (*b*) *Scorpions.* (Order Scorpionida; class Arachnida).

Scorpions live only in the southern parts of the United States. They hide by day under stones, boards, logs, or the loose bark of decayed logs, or in crescent-shaped holes in the ground. At night they come out in search of food, which consists of spiders and large insects. They grasp their victims with their formidable pincers and sting them to death with the poison-sting on the end of their long tail.

A scout living where scorpions are common can have a very interesting time by making a large out-of-door cage for them, with plenty of broken pieces of crockery or drainage tiles for them to hide under. In the spring of the year they go a-courting in a very funny way. Fabre, who studied the habits of a European scorpion found that on spring evenings there was great excitement among them. They all came out to stroll around. Now and then a male scorpion would rush up to a female and they would raise up as though for a sort of wrestling match, and then he would seize her by the claws and back away with her, and continue to lead her around, perhaps for hours, always walking backwards. At last the pair would go off into seclusion in some hole or crevice, the male dragging his willing spouse into the cranny that he selected. There they may remain motionless, holding hands, for 24 hours or more. But the female is at best an ill-mannered hussey, for after the male has provided for the continuation of his kind, she turns around and eats him up, piece by piece. That is certainly a horrible nuptial ceremony and one cannot help wondering if the male knows what is coming to him all the time he is dragging his betrothed around by her wrists, and whether it is the visions of a future feast that make her so ironically docile in following his lead. But in reality, they are doubtless only following an irresistable impulse which we call instinct, and neither knows anything beyond the moment at which it is acting.

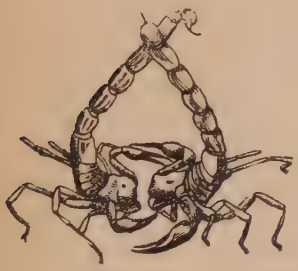


Fig. 21—*Wrestling scorpions*

Evening promenades

Holding hands

Pa scorpion gets his!

The young are born in July, or in some places it may

be later. The eggs are kept in the body of the mother until ready to hatch, which they do immediately after being laid, so soon that many observers have thought that they are born alive. Close observation, however, will show the mother tearing off and pulling away the egg-shell with her jaws, helping to free the helpless babies. These are milky white, like their mother in shape, and at once clamber up on her back, where they continue to live until old enough to care for themselves.

Mamma helps

Despite all of the care bestowed upon her babies, the mother scorpion never thinks of giving them anything to eat. For days they go hungry upon her back, even bursting their skins once, and growing very much in size, without ever having taken a mouthful of food. The mother eats, but offers the babies nothing until finally they get so hungry they can't stand it any longer, and they scamper away to find their own food, and thereafter establish their own tiny houses beneath some rock, or in some hole in the ground.

She eats, but the kids go hungry

If you are interested in scorpions, by all means read the fascinating story of them which Fabre has written. (Life and love of the insect, by J. Henri Fabre. Chapters XVII and XVIII. See Bibilography, page 171, item 27).

3 (*c*) *Orb-weaver spiders.* (Family Argiopidae; order Araneida; class Arachnida).

If you live in the south you are familiar with the very large spider webs, two or three feet in diameter, of yellow silk, supported by very strong strands, which are exceedingly disagreeable to run into in the woods. On these you have seen sitting the huge spiders which make them, very pretty creatures, one must admit; the head-thorax silvery in appearance due to a close-set covering of silver hairs; the great elongate olive abdomen splotched and spotted and striped with yellow and white.

Giant webs

But the most noticeable things about them are the brushes that they wear around their legs, which very much remind one of the brushes that chemists use with which to clean out their test-tubes. They are silk-spiders, *Nephila clavipes*, and while they occur only in the southeast they are only one of the very numerous kinds of orb-weavers, some of which are common in every community.

As no spiders other than orb-weavers build orb-webs,* the orb-weavers may best be recognized by finding them on their webs. These consist of a series of radiating strands, all in one place, supporting a spiral line which winds around and around, forming meshes. Sometimes the thread is looped back and forth on the radia instead of forming a spiral. The tortoise-shell spiders, garden-spiders and other brightly colored spiders, speckled and splotched with yellow and orange and silver and with very large fat egg-like abdomens are orb-weavers, and so are the spiny-bellied spiders, which live mostly in the south and are conspicuous because of their funny shaped angular abdomens, often with several sharp spines.

How a Spider Weaves an Orb-web.

When you have seen a spider's web stretching across a brook, did it ever occur to you to wonder how a wingless creature like a spider ever got it across? The first step in web-building is to make the "bridge," a line connecting two distant objects between which the web will be spun. To do this the spider lifts its abdomen and spins a thread which it lets float loose into the air until it touches and sticks to some distant object, then it hauls in on it until it is taut, and makes it fast. This line is strengthened by crawling across several

Brooklyn Bridge

* Except Uloborus, of which there are only two or three kinds, recognizable from true orb-weavers by their large and long front legs.

times and fastening additional double cables of a kind known as "draglines."

Scaffolding

The next thing is to construct the outer framework of the web. "In doing this it fastens a thread to one point, and then works along to some other point, spinning a dragline as it goes, and holding it clear of the object on which it is walking by means of one of its hind legs. When the second point is reached, the thread is pulled tight and fastened by means of an attachment disk." Several such lines, known as foundation-lines, will be spun, and perhaps another bridge, leaving an irregular open area in the center in which the web proper is to be spun.

Now the spider is ready to build the orb itself, and the first thing is spin a line which will cross the center. It does this in the way above indicated, going around some of the foundation-lines and using its hind feet like hands to hold the web free from contact with any of them, and drawing it taut. Then it returns to the center, and spins one radiating line after another, by an exactly similar process, each extending from the center to the framework. Each time it returns to the center it works a bit on the hub, building there a close irregular net-work of dry silk, to serve perhaps, as its own resting place.

Radii

Stays

When the radii are all in, it spins a spiral line around them, the turns of which are as far apart as the spider can reach. This is the spiral guy-line and its only purpose is to hold the radii, which it crosses at right angles, in position while the web is being spun. After the web is completed the spider goes over it and cuts out this spiral guy-line again, section by section.

Now Mrs. Spider is ready to construct the business-part of her web. She starts at the bottom and spins across the radii a special kind of line that she has not

used before. It is constructed of silk that is elastic like a rubber band, and that remains sticky and so will be useful for catching and holding flies and other insects until she can rush out and take care of them. She loops this back and forward several times at the bottom, and then begins going around the entire web, crossing all the radii in turn, spiral fashion, the turns becoming smaller and smaller until, before reaching the center she stops. This is the viscid spiral. In spinning it she attaches it to a radius, then goes to the next, but before attaching it takes hold of it with a claw or spine of the hind leg and pulls out more line from the spinnerets, so that after she fastens it, it will hang rather loose, and that any fly getting into it, will not break it, but instead it will stretch like a rubber band, and the fly will be likely to become caught in the adjoining spirals.

Sticky

Pretty neat

The web is now practically complete. The area between the viscid spirals and the hub is the "free-zone," left to give the spider means to cross readily from one side of the web to another. In moving about over the web the spider goes on the radii, avoiding contact as far as it can with the viscid spiral, which would be destroyed if touched.

Step easy

Many spiders lie and wait for their prey on the hub; others make a hiding place near the side of the web, as for example in a curled leaf, connecting it by a cable with the hub. While waiting in this hiding place they hold out the cable with one of their feet, and can thus feel any vibration of the web, and rush down to secure their victims. It is just like a scout sitting on the bank, holding a fish-line and waiting to feel a nibble.

Fly-blind

Let's fish in the air for flies

Much more of interest about the webs, silk, and habi of spiders will be found in Chapter IV of Professor Comstock's "Spider book" (See the Bibliography, item 24, page 171).

4 (*a*) *Scale-insects.* (Family Coccidae; order Homoptera).

The city scout may need an introduction to these uninsect-like creatures, but his brother scout of the country could give him that introduction better than any text-book. For the latter knows the "scale" as a serious menace to his father's fruit crop, against which he must spend time and dollars in continual warfare. The most certain place to make their acquaintance is on neglected fruit trees, especially apple or pear, but there are many different kinds of scale-insects, living on many different plants.

The oyster-shell scale (*Lepidosaphes ulmi*) is one of the commonest and easiest to see, looking like an incrustation of tiny oyster-shells on the bark of apple, pear, lilac and other plants. With the point of a knife *Hidden* lift these scales and you will see beneath each one of them the real insect, for the scale is only a covering. You may not recognize it as an insect, either, for there is nothing insect-like about its appearance.

When the baby scale is born it is quite like a normal insect, and crawls around for a few hours until it finds a spot that suits it on a stem or leaf. Then it inserts its long headlike beak into the bark or leaf, and begins one *This is the life!* long eternal suck of plant juice. For now that it has made connection with the "water-main" in the stem or leaf, its beak serves as a supply pipe and is never again disconnected, nor the faucet closed. This "pipe" connection keeps it permanently attached to the spot it has chosen, and as it has no more use for legs it soon looses them, and also looses its antennae, its eyes, and its head, thorax and abdomen all become united into a *No head nor eyes nor nothin'* mere shapeless sac, which if it be a female never grows wings or moves away. While this degeneration is going on it has been secreting a film of wax which covers its back, and which together with the two skins that it casts

on the two occasions when it molts, form the "scale" that covers and protects it. The eggs are laid beneath this scale in August or September in the north and do not hatch until the next spring. South of about New Jersey there are, however, two generations each summer.

The young male insects are more inclined to settle on a leaf than on the stem of the tree. They begin the process of scale building in a way similar to that of the females, but include only one of their cast skins in it. Thereafter their lives are quite different, for they develop into a resting stage (pupa) and emerge as very tiny powdery white winged insects. They have only two wings, and a sharp pointed tail. The scout is not likely to find these delicate adult male scale insects in nature, but he can easily get them by putting away in a box branches and leaves well covered with young male scales, which are smaller and somewhat different in shape from those of the females. In this way not only will winged males be bred, but the young will hatch from the eggs, and crawl all over the sides of the box, like lice. The scout should examine them with a magnifying glass and see how much more insect-like they appear than do their mothers.

The men sprout wings

The San Jose scale, pronounced san hoe-zay, (*Aspidiotus perniciosus*) on fruit-trees; the scurfy scale, (*Chionaspis furfurus*) on apple, pear, currants, and other plants; the pine-scale, (*Chionaspis pinifolia*) on pine needles, white in color and quite pretty; the rose-scale, (*Aulacaspis rosae*), which makes rose and berry stems look as though plastered with whitewash; the purple scale, (*Lepidosaphes beckii*) and the red scale, (*Chrysomphalus aurantii*) both on orange, are other common kinds of scales, with habits essentially the same as those described for the oyster-shell scale, although the details differ. They all are of the sort called

armored scales, because of the fact that they form the scale-covering for their bodies out of wax and their cast skins.

Naked

Besides the armored scales there are other scale insects called *naked scales* because they do not build any protection over their bodies, and some of them wander about freely over the plant, keeping their legs and antennae all their lives. The mealy bugs (*Pseudococcus*)

Fig. 22—*Black-scales on an olive-branch*

so often found on hot-house plants; the black scale of the orange and olive (*Saissettia oleae*) the terrapin-scale (*Eulecanium*) on fruit and many shade trees, coving their stems with black pustules; and the cottony maple-scale (*Pulvinaria vitis*) which looks like tufts of cotton growing out of a brown scale on the under side of maple leaves, are all common examples of the naked scales.

4 (*b*) *Plant-lice.* (Family Aphididae; order Homoptera).

Often beneath the leaves or along the stems of all sorts of plants one finds close-packed hordes of very small soft-bodied creatures, mostly wingless, or some of the bigger ones may have rather large colorless wings, and all tapping with their beaks the flowing sap of the plant. "Little animated drops of sap on legs," Mrs. Comstock says of them. They are plant-lice or aphids. See how they stand, all heads to the front, so closely packed perhaps that there is no more standing-room, and yet they could have all the plant to feed upon. All day long they suck the sap, and if now and then one tires of its position it may pull out its long hoselike beak, fold it back between its legs, and waddle slowly away, scrambling awkwardly over its feebly protesting mates. Watch them a bit, with a lens; awkward looking "little ninnies," with great eyes and a wondering expression. Tease them with a straw, and their response is to feebly wave a protesting leg, or if too much harrassed they may slowly turn around, pivoting on their inserted beaks.

Tanks

All-day suckers

Part of the sap is again excreted in the form of honeydew, and this is eagerly sought after by ants which prize it as highly as a toper does his bottle of rum. Therefore you are likely to find ants in solicitous attendance on the aphids which are sometimes styled their "cows." One kind of ant even builds sheds around the branches over their aphids to protect them. Such soft, helpless, and almost stationary little dubs as these aphids are easy meat for predacious enemies, amongst the worst of which are the aphis-lions, and lady-beetles. The ants, however, are good and ready to fight in their protection, as you will likely notice. The aphids themselves have one method of defense. Near their tails they have on

Ant's rum

Their cattle

Fight!

each side a tube sticking out. From this they secrete a kind of wax. When Mr. Aphis-lion comes slipping around, they try to jab these tubes into his eyes and smear them with wax. Then before he can get them cleaned off and see what has happened, aphis has pulled up his beak and waddled away. Mrs. Comstock says that it is like fighting a man by throwing a bucketful of paste over his head.

Smear him, Aphy!

Out in California, a packer who outfitted the author for a trip into the Sierras, once told him that he often greatly frightened easterners by telling them that they must beware of a dreadful animal, the woolly aphis, which lived in certain valleys in the mountains. The animal is dreadful enough, all right (to the trees) but he never mentioned that it is only an eighth of an inch long instead of being like a bear or lion of some sort or other. Even the tenderfoot scout doubtless knows the really woolly aphis by sight if not by name. They form masses that look like tufts of cotton all over the stems of alder, and on the trunks and leaves of apple, and on elm. They are plant-lice, and the "cotton" is made of threads of wax which they secrete.

Woolly aphis

I take on the tenderfeet!

Efficiency experts

No waste effort or false starts in the aphid life-cycle. It's all figured out and ready, what to do if food runs short, if the plant dries up, if cold weather comes, if spring comes again and what not. The story of the green peach-aphis will do to illustrate.

The Green Peach-aphis, Called also Spinach-aphis (Myzus persicae or Rhopalosiphum persicae)

A shiny black egg on a peach-tree (or plum or cherry) hatches in the spring and out steps a baby aphid. She grows up (they are all females) by the time the blossoms open into a pink wingless individual which is known as the stem-mother; her offspring are destined, by the end

Stem-mother

Fig. 23—*Mother Aphis*

of summer, to wholly populate many plants; without mating with any male she gives birth to living young, not pink, but yellowish green in color, with three dull darker lines on the abdomen; they also are wingless when grown and all females; they feed on the under sides of the young peach leaves and cause them to curl; still without mating, these also give birth to living young; they also are all females, and as they grow up many of them develop wings; they are now green and black.

Green kids

Woman suffrage

By this time the whole colony has all the peach juice it wants, and they are hungry for vegetables. Women always do want a change of diet, anyway. Potato, tomato, spinach, eggplant, cabbage, turnip, radish, cauliflower, cucumber, mustard, beets, rutabagas, pepper, horse-radish, celery, rhubarb, okra, lettuce, it makes no difference what, but they *must* have it and so off they sail on their new wings to the garden (the first wings in three generations) and each lands upon a young vegetable-plant. Then once more, without mating, they give birth to living female young, the fourth generation of amazons. These do not develop wings, and are green in color, like the second generation (their grandmothers) but without the dark stripes that grandma had on her abdomen.

Fig. 24—*A winged female aphis*

Suffering cats! this is getting serious

Man, mere man, where art thou?

Now follows generation upon generation of wingless females, with never a male, all born alive, none developing wings; they would completely cover the vegetable-plants upon which they live if not held in check. Now and then a plant becomes too crowded; then winged individuals are developed which migrate to other vegetable plants. In the fall of the year the vegetable-crops begin to reach their limit of usefulness to Mrs. Aphid and she either gets hungry for peach again, as were her long distant ancestors, or she concludes it time for a change, and a generation appearing which develop wings for this particular purpose, they fly back to the peach trees, settle along the veins of the leaves, and give birth to young of both sexes, which grow up into pink wingless females (like their long distant stem-mothers) and winged males.

At last!

Cold weather is now approaching and one can fancy Jack Frost saying "Now I've foxed you, *how are you going to get through the winter*, you amazon people?" But Mrs. Aphid thumbs her nose at Jack, takes unto herself a husband (who has flown hence from some other tree, bringing into the colony new life and blood) and turns the whole future aphid colony into a black shiny winter-egg which she places in crevices of the buds, proof against the winter's cold, ready to hatch out a new stem-mother in the spring.

In California, where there is no cold, they may just go on living for years, without any males being born at all.

5 (*a*) *The nest of some solitary bee or wasp, mud-dauber excluded;* (Order Hymenoptera).

The nests of the solitary bees and wasps may be found most readily in any one of four kinds of places, each of which will be discussed separately.

a. In the stems of raspberry vines or other pith-containing plants.

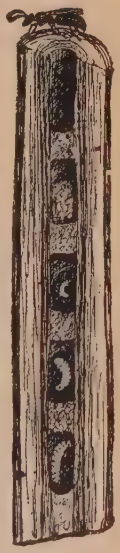
b. In beams and posts.

c. In gravel or clay banks.

d. In open sandy places.

Nests in Stems

At any time of the year if you search brambles or dead stems of sumac or elder you will find when you split them open that some of them contain bees or wasps, for such places are much in favor by many kinds of bees and wasps for building their nests. The nests of the wasps may be told from those of the bees by the fact that the partitions between the cells in the nests of bees are made of chewed up pith or sawdust, and the nests of the wasps are stored with paralyzed insects while those of the bees are stored with bee-bread* as food for the young.



Building a home

One of the kinds of bees very commonly found in almost any part of the United States nesting in such places is the little carpenter-bee (*Ceratina*) a small, dull-blue or greenish bee. Mrs. Comstock in the Handbook of Nature Study has written in such an interesting way of the habits of these bees that we shall quote her:

"In May the mother bee selects some broken twig of sumac, elder or raspberry, which gives her access to the pith; this she at once begins to dig out, mouthful by mouthful, until she has made a smooth tunnel several inches long: she then gathers pollen and packs bee-bread in the bottom of the cell to the depth of a quarter-inch, and then lays upon it, a tiny white egg. She then brings back some of the chips of pith and glues them together, making a partition about one-tenth of an inch thick, which she fastens firmly to the sides of the tunnel; this is the roof for the first cell and the floor of the next one; she then gathers more pollen, lays another egg, and builds another partition.

* A mixture of pollen and honey.

"Thus she fills the tunnel, almost to the opening, with cells, sometimes as many as fourteen; but she always leaves a space for a vestibule near the door, and in this she makes her home while her family below her are growing up.

"The egg in the lowest cell of course hatches first; a little bee grub issues from it and eats the bee-bread industriously and grows by shedding his skin when it becomes too tight; then he changes to a pupa and later to a bee resembling his mother. But, though fully grown, he cannot get out into the sunshine, for all his younger brothers and sisters are blocking the tunnel ahead of him; so he simply tears down the partition above him and kicks the little pieces of it behind him, and bides his time until the next youngest brother tears down the partition above his head and pushes its fragments behind him into the very face of the elder which, in turn, performs a similar act; and thus, while he is waiting, he is kept more or less busy pushing behind him the broken bits of all the partitions above him. Finally, the youngest gets his growth, and there they are all in the tunnel, the broken partitions behind the hindmost at the bottom of the nest, and the young bees packed closely together in a row with heads toward the door. When we find the nest at this period, we know the mother because her head is toward her young ones and her back to the door. A little later, on some bright morning, they all come out into the sunshine and flit about on gauzy, rainbow wings, a very happy family, out of prison.

Just wait for brother, Johnnie!

Family in the stem

"But if the brood is a late one, the home must be cleaned out and used as a winter nest, and still the loyal little mother bee stays true to her post; she is the last one to enter the nest; and not until they are all housed within, does she enter. It is easy to distinguish her for her poor wings are torn and frayed with her long labor of building the nest, until they scarcely serve to carry her afield; but despite this she remains on guard over her brood, for which she has worn out her own life."

Poor Ma!

The wasps that live in these twigs have a somewhat similar story, except that they often use the abandoned

tunnels of the carpenter-bees instead of making their own new ones, and it is probable that the mother wasp does not remain to watch over her brood.

Lazy!

Nests in Beams and Posts

Fig. 26—*Nest of the carpenter-wasp*

A sure enough carpenter

In the southern part of the United States there are two large insects that may be found throughout the summer building nests in logs or in posts around buildings, and which have won for themselves by this habit the name of carpenter-bee (*Xylocopa*) and carpenter-wasp (*Monobia quadridens*). The carpenter-bee (*Xylocopa*) looks at first sight like a bumblebee and is often mistaken for one, but if we look at the hind leg of the female we will see that it is covered with a dense brush of hairs which collect and carry pollen and that it has no smooth shining pollen-basket, such as characterizes the legs of bumblebees. Furthermore, bumblebees make a honey-comb and have many workers in one nest, as do honey bees, while the mother carpenter-bee makes her nest all by herself without the assistance of any workers. To distinguish the sexes of Xylocopa, and to distinguish our two eastern species from each other, see Appendix A, paragraph 3:B (a), page 176.

Nests in Gravel or Clay Banks

There are many kinds of bees and wasps that like to make their nests in such places, but the most abundant of these and the kind which one may be quite sure of

finding on a hot summer day in almost any part of this country are the nests of sweat-bees (*Halictus*). These bees will be seen flying about such a bank and every now and then alighting and entering their tiny nests, which may measure not more than one-sixteenth of an inch in diameter, or just large enough to let the bee enter, the size depending upon the size of the particular kind of sweat-bee. If you will look closely at the bank, you will see it studded with many of these little nests and you will see that in many of the nests there is a bee standing in the passage with her head at the entrance. These are the guard bees. They stand on guard at the entrance of the nests and only allow individuals belonging in that nest to enter, fighting off any other creature which comes along and desires admittance. Just within the entrance the passageway of the nest is widened so that two or more bees may pass, and when a bee returns to enter the nest she is recognized by the guard bee, which then steps back into the wider part of the passageway and allows her to pass. Within the nest there is a common hallway which belongs to all of the bees using that particular nest, from which on each side there open out branch passages into individual rooms, and each of these rooms is the property of one single bee, and in them she raises her own brood. The nests of these bees may be compared to a city apartment house with its porter, its common hallway, and its individual apartments.

Guards

The password, please

Apartments to let

Nests in Open Sandy Places

Especially in the southern and western parts of our country, or for that matter almost anywhere except in the extreme North, open sandy patches of ground are the favored nesting places of many kinds of digging bees and wasps. The sand along the seashore back from the reach of the tides is tenanted by many colonies of sand-wasps, and by waiting quietly and watching carefully

on a hot sunny day in an open sandy spot almost anywhere, one may be sure of seeing different kinds of wasps arrive and alight on the sand. After a few seconds they kick away the sand grains and enter little holes in the sand or earth. It is not so easy to dig down into these holes, without losing track of them before reaching the brood chamber, but if one can succeed in doing so he will find the young wasps, little, maggot-like creatures, and a supply of fresh or stung and paralyzed insects placed there by the mother for their food. If the nest is one of a bee, instead of insect food there will be bee-bread, which is a mixture of honey and pollen.

The solitary wasps use their sting, not for offense, nor to any great extent for defense, but to paralyze some insect which they intend to store in their nest as food for their young. This is accomplished by stinging the victim in a nerve center. The victim goes into a trance which lasts many days, so it can be safely left in the nest until the young wasp-grub is ready to eat it, without danger of its not being fresh.

Pop him on the solar plexus

Cold-storage grub

5 (*b*) *Bumblebees and their nest.* (Bombus; family Bombidae; order Hymenoptera).

The tale of a bumblebee can be no better told than in the words of Mr. Sladen, an Englishman, who devoted his life to their intimate study.

"The story of the life of the bumblebee is largely that of the queen. From start to finish she is the central and dominating personage upon whose genius and energy the existence of the race depends. For she alone survives the winter, and, unaided, founds the colony in which she takes the position of its most important member. The queen is raised in company with many others in July or August, the rearing of the queens being the final effort of the parent colony. The young queens are shy and show themselves very little. The males course up and down hedgerows, or hover over the surface of fields and around trees, in the hope of finding their

mates. Each species has its particular kind of hunting-ground. Immediately after fertilization the queen seeks a bed in which to take her long winter sleep. The queens of some of the species hibernate under the ground, others creep into moss, thatch, or heaps of rubbish. The underground-hibernating species almost invariably choose the upper part of a bank or slope facing north or northwest, though generally near trees.

Holed in for winter

"In such banks I have sometimes found great numbers of queens, . . . and it is easy to discover them, because in burrowing into the ground each queen throws up a little heap of fine earth, which remains to mark the spot until the rains of autumn wash it away. The burrows are only one to three inches long, and if the bank is steep they run almost horizontally. They are filled with the loose earth that the queen has excavated. The queen occupies a spherical cavity having a diameter of about 1⅛ inches.

"It is evidently damp and not cold that the queens try to avoid. Indeed, the northern aspect shows that they prefer a cold situation, and the reason is easily guessed. The sun never shines on northern banks with sufficient strength to warm the ground, so that the queens do not run the risk of being awakened on a sunny day too early in spring, for the queen bumblebee is very susceptible to a rise in temperature in the spring, although heat in autumn, even should it amount to 80° F., will not rouse her when once she has become torpid. The queen easily takes fright while she is excavating her burrow, and I find that many burrows are begun and not finished.

It's nice to get up in the springtime, But it's nicer to lay in her bed

"The queen always fills her honey-sac with honey before she retires to her winter hole. This store of liquid food is no doubt essential for the preservation of life, and is especially needed, one would think, during September, when the ground is often very dry and warm.

Uneasy sleep

"During the first few weeks the queen sleeps lightly, and if disturbed, for instance by a visit from an earwig, she wakes up, creeps out of her burrow and flies away; but when the weather grows cold she folds her legs and bends as in death, sinking into deep torpor, from which she is not easily aroused. The period of torpor lasts

about nine months. On sunny days in March the queens of hardy species may be seen busily rifling the peach-blossom, willow catkins, and purple dead-nettle, but in the afternoon as the sun descends and the air grows chilly they creep into hiding-places, where they relapse into semi-torpor, remaining in this condition until a favorable day again rouses them into activity.

Dead to the world for nine months

"The weather improving, the periods of animation become more frequent and last longer. Now each queen sets to work to search for a nest in which to establish her colony. The nest is usually one that has been made and afterwards vacated by a field-mouse, vole, or other small mammal, and consists of fine soft fragments of grass or moss, or it may be leaves, woven into a ball with a small cavity in the middle. Most of the species choose a nest that is under the ground, access to which is obtained by a tunnel varying in length from a few inches to a yard or more, but generally about two feet. The remaining species dwell in nests on the surface of the ground hidden in thick grass or under ivy. In places where there is much moss or soft dead grass the queen may sometimes construct the entire nest herself. It often happens that the mouths of the holes leading to the underground nests are overgrown with grass or ivy and half closed with debris, consequently they are not easily discovered, and the queens of the underground-nesting species may be seen throughout the spring hovering over the ground in woods and meadows making a diligent search for them; now and then the queen alights in a promising-looking spot and makes a closer examination of the ground on foot.

Mouse's nest for a house

"Having found a suitable nest, the queen becomes rather excited and visits it frequently. Her first flight from her new home is a momentous one, for from it she has to learn how to find her way back again to it. Having accustomed herself to the appearance of the entrance by crawling around it, she ventures to take wing and poises herself for a moment facing the entrance. Then she rises slowly, and, taking careful notice of all the surroundings, describes a series of circles, each one larger and swifter than the last. So doing she disappears, but soon she returns and without much diffi-

Exciting days

The lay of the land

culty discovers the entrance. Similar but less elaborate evolutions are made at the second and third departures from the nest, and soon her lesson has been learned so well that her coming and going are straight and swift.

"She now spends a good deal of time in the nest, the heat of her body gradually making its interior perfectly dry. If the nest has been long unoccupied and is in bad repair, she busily sets to work to reconstruct it by gathering all the finest and softest material she can find into a heap, seizing and pulling the bits of material with her jaws and passing them under her body backwards with her middle and hind pairs of legs; then she creeps into the middle of the heap and makes there a very snug and warm cavity, measuring about an inch from side to side, but only about five-eighths of an inch from top to bottom, with an entrance at the side just large enough for her to pass in and out.

She feathers her nest

"In the center of the floor of this cavity she forms a little lump of pollen-paste, consisting of pellets made of pollen that she has collected on the shanks (tibiae) of her hind legs and moistened with honey. These she moulds with her jaws into a compact mass, fastening it to the floor. Upon the top of this lump of pollen she builds with her jaws a circular wall of wax, and in the little cell so formed she lays her first batch of eggs, sealing it over with wax by closing in the top of the wall with her jaws as soon as the eggs have been laid. The whole structure is about the size of a pea.

Eggs in the bee-bread

"The queen now sits on her eggs day and night to keep them warm, only leaving them to collect food when necessary. In order to maintain animation and heat through the night and in bad weather when food cannot be obtained, it is necessary for her to lay in a store of honey. She therefore sets to work to construct a large waxen pot to hold the honey. This pot is built in the entrance passage of the nest, just before it opens into the cavity containing the lump of pollen and eggs, and is consequently detached from it.

Hatching her eggs

The queen's great honey-pot

The completed honey-pot is large and approximately globular, and is capable of holding nearly a thimbleful of honey. . . . . It is exceedingly delicate and fragile, the wall being thin as well as soft; but being left undis-

turbed, it remains water-tight for about a month, which is as long as it is needed.

Every queen her own potter

"The queen re-shapes the mouth of the honey-pot daily according to her requirements. Thus, at night, when the honey-pot is full of honey, the mouth is attenuated and small—only about a quarter of an inch across, but in the morning after it has been emptied the orifice is larger, the height of the pot being reduced.

The children

"The eggs hatch four days after they are laid. The larvae are maggot-like, being hairless and legless, and as they begin to grow they assume a curled shape, which is maintained until they are about to pupate. The larvae, however, like the eggs, cannot be seen, for the queen keeps them covered with wax, in which they are completely enclosed as in a bag or skin.

Feeding the kids

"The larvae devour the pollen which forms their bed, and also fresh pollen which is added and plastered on to the lump by the queen. The queen also feeds them with a liquid mixture of honey and pollen, which she prepares by swallowing some honey and then returning it to her mouth to be mixed with pollen, which she nibbles from the lump and chews in her mandibles, the mixture being swallowed and churned in the honey-sac. To feed the larvae the queen makes a small hole with her mandibles in the skin of wax that covers them, and injects through her mouth a little of the mixture amongst the larvae, which devour it greedily. Her abdomen contracts suddenly as she injects the food, and as soon as she has given it she rapidly closes up the hole with her mandibles. While the larvae remain small they are fed collectively, but when they grow large each one receives a separate injection.

"As the larvae grow the queen adds wax to their covering, so that they remain hidden. When they are about five days old the lump containing them, which has hitherto been expanding slowly, begins to enlarge rapidly, and swellings, indicating the position of each larva, begin to appear in it. Two days later, that is, on the eleventh day after the eggs were laid, the larvae are full-grown, and each one then spins around itself an oval cocoon, which is thin as paper, but very tough. The queen now clears away the most of the brown wax

Cocoons

covering, revealing the cocoons, which are pale yellow.

"These first cocoons number from seven to sixteen, according to the species and the prolificness of the queen. They are not piled one on another, but stand upright side by side, and they adhere to one another closely, so that they seem welded into a compact mass. They do not, however, form a flat-topped cluster, but the cocoons at the sides are higher than those in the middle, so that a groove is formed; this groove is curved downwards at its ends, and in it the queen sits, pressing her body close to the cocoons, and stretching her abdomen to almost double its usual length so that it will cover as many cocoons as possible; at the same time her outstretched legs clasp the raised cocoons at the sides. In this attitude she now spends most of her time, sometimes remaining for half an hour or more almost motionless save for the rhythmic expansion and contraction of her enormously distended abdomen, for nothing is now needed but continual warmth to bring out her first brood of workers.

Brooding over her babies

"After a period of rest the larvae change to pupae, heads uppermost. About the twenty-second or twenty-third day after the eggs are laid the perfect worker bees are formed, and, biting a hole through the tops of their cocoons, they creep out; those in the cocoons in the middle of the groove, which have been kept warmest, emerging a day or two earlier than those at the sides. In the work of biting open her cell the emerging bee is generally assisted by the queen or workers, and she makes several attempts to get out before the orifice is large enough to permit her thorax to pass through.

Coming out into society

"The coat of the freshly emerged bee is matted and stuck down with moisture, and is of a uniformly dull silvery-grey color. Her legs are weak and unsteady, and almost the first thing she does is to totter to the honey-pot, where she slowly unfolds her proboscis and takes a sip of the life-supporting drink. Then, refreshed and strengthened, she returns to the brood and nestles under the warm body of her parent. About forty-eight hours only are needed for her to acquire the handsome, well-groomed appearance and the bright rich colors of her mother, whom, indeed, she now resembles in every way

Have a drink?

Feel better now

except in her diminutive size.

Mother, you are growing old

Four or five weeks of labor have told heavily upon the queen; the tips of her wings have become torn and tattered, and when she goes out to gather food she works less energetically than formerly, often stopping to rest on the leaf of a tree or on a blade of grass. As soon as she finds that her children are able to collect sufficient honey and pollen for the maintenance of the little family, she relinquishes this labor, and henceforth devotes herself entirely to indoor duties, laying eggs in increasing numbers and assisting the workers to incubate and feed the brood. Sometimes, however, the workers of the first batch are not sufficiently large or numerous to support the colony. In this case the queen continues going out to work until more workers appear.

Ma still supports the family, though

"The workers do not continue to use the queen's honey-pot, but, leaving it to grow mouldy and decay, they store the honey they gather in the cocoons they have vacated, adding wax to the rims of these to increase their capacity.

New honey-pots

"The pollen, which is really a stiff paste of pollen and honey, is never put into the same cells as the honey. During the feeding of the first larvae the queen deposits her pollen around the cell that contains them; here it is soon consumed, so that no receptacle is needed or made for it. Later on, however, as the comb grows, the pollen is placed in special cells, the nature of which depends upon the species.

"Succeeding batches of workers emerge in due time and the population of the colony grows rapidly, a few fresh workers emerging every day; these workers are still larger than the earlier ones, and they are very capable and energetic.

A life of hard work

"Every active moment in the worker's life, which lasts about four weeks, is employed in furthering the prosperity of the colony. Even before her full colors have appeared she begins to nurse her baby sisters, spreading her body over them and feeding them. The adult worker spends the greater part of the day journeying to and from the flowers, and she seldom returns home without her abdomen distended with honey, and the

Sister tends the babies

tibia of each of her hind legs bearing a large pellet of pollen.

Loading the pollen cells and filling the honey-pots

"It is interesting to watch the worker put away her load. After entering the nest she runs about, feeling and smelling with her antennae, in search of cells to receive it. Having discovered a receptacle containing pollen, she takes a step forward so as to bring her hind legs exactly over the mouth of it, and rubbing them together, she detaches the two pellets, which drop into the cell. Then she may turn round and, putting her head into the cell, may spread and plaster down the pollen with her mandibles, but often she leaves this to be done by another worker. Hastening to a cell containing honey she buries her head in it, and her abdomen is seen to contract as she regurgitates the honey. Next minute she is out and away to collect another load. She does not always drop her pellets of pollen at the first attempt, but, just as she is about to dislodge them she appears to be often seized with doubt as to whether they will fall into the cell, and, turning round, puts her head into the cell: having thus reascertained its exact position, and perhaps reassured herself of its suitability, she again steps forward, and this time lets fall her load.

Queenie sees that they do it right

The queen, should she be near, is much interested in the arrival of the pollen, and on one occasion I saw her nibble some of it off the worker's leg while the latter was engaged for a moment with her head in the cell.

Late hours and all busy

"When the weather is warm the workers are particularly industrious in the cool of the evening, bringing home heavy loads until dusk. At night the colony is even more animated than in the day-time, for the whole population is now at home, and each bee is occupied, some building, some feeding the larvae, but the great majority slowly creeping over the brood in all directions, stopping now and then for a moment or two to spread their bodies over some portion of it. No special attention is paid to the queen.

"After the queen has laid altogether from 200 to 400 eggs that will develop into workers, the number depending upon the species and the vigor of the queen, she begins to lay others that are destined to produce males and queens. It is almost impossible to distinguish the

male brood from the worker brood, but the full-grown queen larvae and the queen cocoons may be known by their larger size. The queen larvae take longer to attain their full size than either the worker or the male larvae. In a cluster of cocoons containing both males and queens the queens are on top and the males at the sides. On an average, taking one nest with another, it may be estimated that nearly twice as many males as queens are produced. The total number of males and queens reared varies from 100 to 500, according to the staff of workers.

"Sometimes a strange scene may be witnessed at the laying of the male and queen eggs. The workers, hitherto so amiable, are suddenly seized with anger and jealousy, for as soon as the queen has closed the cell and turned away, one or two of them hurriedly commence to bite it open, their wings quivering with excitement. The queen, however, seems to have expected this behavior, and, quickly returning to the cell, throws down the conspirators, repairs the cell, and again departs. But directly her back is turned a worker again attacks the cell, and again the queen beats it off. And so continues a game of attack and defence for five or six hours, sometimes one worker, sometimes another, being the offender. At last the workers leave the cell unmolested. That their object is to destroy the eggs is proved by the fact that when sometimes a worker succeeds in reaching the eggs I have seen it seize one and devour it with much relish.

Sis don't want any brothers hanging round

She tries to kill them off

"The young males leave the nest as soon as they are able to fly, and do not return again for food or shelter. Their life, though idle, is brief, and does not last more than three or four weeks. The young queens may sometimes be seen returning to the nest, occasionally with pollen on their legs, but they, too, soon leave it for good when they mate, and seek their winter quarters.

So brother never stays at home

"As the old queen ages she gradually loses her hair. First, the greater part of the abdomen, and then the central part of the thorax, become more or less bald. When most of the young queens have emerged the number of workers diminishes rapidly, and is soon reduced

Horrors! the queen is growing bald!

to a few dozen of the youngest and strongest. These drop off one by one. Flowers grow scarce, the workers become idle and listless, and the store of honey that only two or three weeks previously filled so many cells is quickly consumed. The comb grows mouldy, and the old queen dies. And so decay and death overtake the once busy community.

Come death and quick decay

"Sometimes in the case of species whose colonies end their existence in the height of summer, the aged queen spends the evening of her life very pleasantly with her little band of worn-out workers. They sit together on two or three cells on the top of the ruined edifice, and make no attempt to rear any more brood. The exhausting work of bearing done, the queen's body shrinks to its original size, and she becomes quite active and youthful-looking again. This well-earned rest lasts for about a week, and death, when at last it comes, brings with it no discomfort. One night, a little cooler than usual, finding her food supply exhausted, the queen grows torpid, as she has done many a time before in the early part of her career; but on this occasion, her life-work finished, there is no awakening."

Home for the aged

Eternal sleep

A colony of bumblebees may be examined safely by pouring into it an ounce or so of carbon tetrachloride. The gas at once stupifies the inmates, and the nest may be opened and examined. Often in such a nest one finds queens which resemble the Bombus queen, yet which differ in some respects. These are usurper bees (*Psithyrus*) and what they are there for, is explained as follows by Mr. Sladen:

Usurper bees

"The most interesting and, in my experience, the deadliest enemies to which several of the commonest species of humblebees are liable to fall a prey are bees so closely resembling the true humble-bees themselves that only a student can tell the difference between them.

"Each species of *Psithyrus* breeds only in the nests of its own particular species of *Bombus*. The usurper bees produce no workers. It is the practice of the *Psithyrus* female to enter the nest of the *Bombus*, to

sting the queen to death, and then to get the poor workers to rear her young instead of their own brothers and sisters.

"The way in which the Psithyrus queen proceeds in order to ensure the success of her atrocious work has all the appearance of a cunning plan, cleverly conceived and carried out by one who not only is a mistress of the crime of murder, but also knows how to commit it at the most advantageous time for herself and her future children, compelling the poor orphans she creates to become her willing slaves.

The dreadful villain's plot

"The queens hibernate solitarily in the ground like the Bombus queens, but they do not quit their winter quarters until after the Bombus queens have emerged, and most of them are already engaged in rearing their first batch of workers.

"Psithyrus much resembles her victim, the Bombus queen, in appearance, being about the same size, and, like her, having a furry black and yellow coat. But the most remarkable feature about the Psithyrus queens is their exceedingly thick and hard skin, covering them like a coat of mail and protecting them from the stings of the Bombi. The segments of the abdomen, in particular, are very hard and lap tightly and closely over one another, there being no wax-yielding membrane between the dorsal segments, so that it is very difficult for an adversary to force her sting between them. Their coats are thin, perhaps as a compensation for the extra thick skin, many thick-hided animals lacking hair. Their stings are stouter and more curved than those of Bombus: it is interesting to note that the sting in the queen honey-bee, who also uses it for killing queens, is curved, while in the worker honey-bee the sting is straight.

Disguised like the queen

Clad in an armor

"The movements of the Psithyrus, whether flying or walking, are slow and awkward. When visiting the flowers in search of food she does not travel systematically from blossom to blossom like an industrious bumblebee, but settling upon a bloom she sips lazily sufficient nectar to satisfy her immediate need, and afterwards is very likely to become drowsy. Fatigued by the exertion

Lazy

of obtaining food for herself, she is plainly incapable of the sustained effort that would be needed had she to provide for the wants of her young.

"Whenever the weather is pleasant she searches leisurely for a nest of the particular species of Bombus which it is her instinct to victimize. In this work she is guided, like a dog, largely by the scent. In her wanderings the Psithyrus may find and enter the nest of some other species of Bombus. Having succeeded in making herself acceptable to the inhabitants, she becomes a temporary lodger in this nest, making it her headquarters and returning to it for meals and also to pass the night.

Nosing out a Bombus nest

"The majority of the Psithyrus queens discover the nests of their victims when only the first batch of workers has emerged, and this is the most favorable time, for these early workers are less hostile to strange queens than are the workers that emerge later. If the Psithyrus fails to find the nest until the workers have become numerous they set upon her with great fury, and, after some time, generally succeed in killing her by stinging her in a vulnerable spot, as for instance, in the neck. It is, therefore, necessary for the Psithyrus to find the nest before many workers are out, but it would not be to her advantage to kill the queen until the latter has laid the greater number of the worker eggs; and, as a matter of fact, she does not do so.

Fight!

"The Bombus queen, on first meeting the Psithyrus in her nest, shows a certain amount of agitation, and may advance to attack her, but, her courage failing, she draws back. The Psithyrus, however, treats the queen with good-natured indifference, unless the latter becomes disagreeably aggressive, and then all she does is to lift occasionally a warning leg, or to creep away and hide herself like a coward in the nest material. If the workers attack her, she tries to rub them off with her legs, and slips into a crevice between the clusters of cocoons, or into the nest material; but, protected by her coat of mail, she has little cause to fear getting stung.

Queenie gets a scare

"Although the Psithyrus during the first few days flies occasionally to and from the nest, I have seen no

evidence that she brings home any food, or that she helps in any way to rear the Bombus brood. Her first care is to ingratiate herself with the inhabitants, and in this she succeeds so well that the workers soon cease to show any hostility towards her. Even the queen grows accustomed to the presence of the stranger, and her alarm disappears, but it is succeeded by a kind of despondency. Her interest and pleasure in her brood seem less, and so depressed is she that one can fancy she has a presentiment of the fate that awaits her. It is by no means a cheerful family, and the gloom of impending disaster seems to hang over it.

An unwelcome guest

Big gloom

"But while the queen grows more dejected, the Psithyrus grows more lively, and takes an increasing interest in the comb, crawling about over it with unwonted alacrity, and examining it minutely.

Only Psithyrus wears a smile

"The poor Bombus queen appears to have no chance of victory over the well-armed Psithyrus. I have taken a great many nests in all stages, but have seen no evidence to show that the Bombus queen ever succeeds in killing the Psithyrus, or that she ever escapes being destroyed by the latter.

Certain death at last for queenie

"I believe the Psithyrus queens do not kill one another, for I have never found a dead Psithyrus in a nest ruled by a Psithyrus. If several Psithyri find the same nest only one remains, although the others may make it their headquarters for a few days. As might be supposed, the Psithyrus is at first very prolific, but she ages and fails more quickly than a Bombus queen.

"The Psithyrus queen pays close attention to her new-laid eggs for several hours, giving the workers no chance to molest them, but the workers soon get reconciled to them, and henceforth they feed and tend the Psithyrus brood with as much devotion as if it were of their own species: indeed, they seem sometimes to show a greater fondness for it."

Adopted at last

The above accounts are taken from The Bumblebee, by F. L. W. Sladen. (See Bibliography, page 173, item 37).

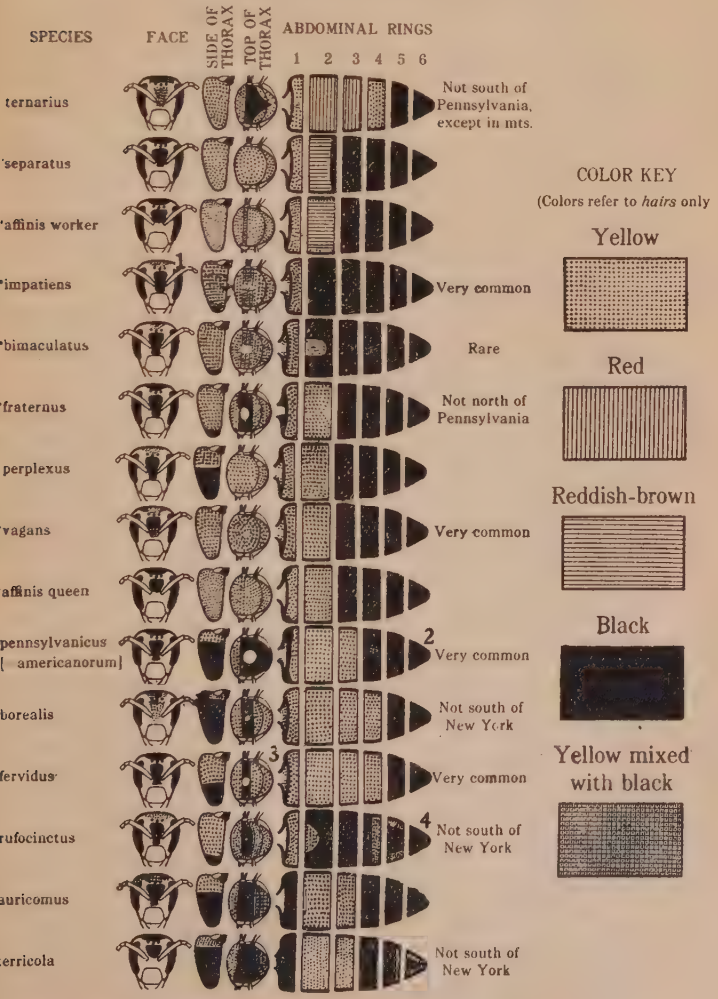
HOW TO TELL USURPER-BEES (PSITHYRUS) FROM TRUE BUMBLEBEES (BOMBUS) AND THE MALES FROM THE FEMALES OF EACH

	ABDOMEN	HIND LEGS	ANTENNAE	FACE	HAIRINESS
BOMBUS QUEEN AND WORKER	6 rings; not curved down at tip; no ridges at tip beneath; ending in a little point and sting.	With pollen basket, which is smooth and shiny.	12 segments	Usually black	Densely hairy
PSITHYRUS QUEEN	6 rings; much curved down at tip; two strong ridges underneath near the tip; ending in a little point and sting.	No pollen basket, convex and hairy.	12 segments	Black	Hairs sparse
BOMBUS MALE	7 rings; not curved down, and without ridges at tip; bluntly rounded at end, without a sting.	No pollen basket, more or less convex and hairy.	13 segments	Usually white	Hairs dense
PSITHYRUS MALE	7 rings; not curved down, and without ridges at tip; bluntly rounded at end, without a sting.	No pollen basket, convex and hairy	13 segments	Black	Hairs sparse, more in bunches

It will be seen from the above, that while the Psithyrus queens can easily be distinguished from those of Bombus, it is quite difficult to tell the males apart. The queens and workers of the Bombus are rarely very different, the one from the other, except in size.

CHART FOR NAMING QUEEN AND WORKER BUMBLEBEES FROM EAST OF THE MISSOURI AND MISSISSIPPI RIVERS

In the GULF STATES including EASTERN TEXAS and ARKANSAS only starred kinds occur
In FLORIDA live only those marked with two stars



[1] Or all black. [2] First ring may be all yellow. [3] Thorax all yellow in variety *dorsalis*. [4] Rings 2, 3, and 4 rarely red-brown

6 (*a*) *Back-swimmers.* (Notonecta; family Notonectidae; order Hemiptera).

Topsey turvey bugs

In almost any little pond or pool of water in the United States one may find boat-shaped insects, one-half an inch or a little less in length, poised upside down in the water, their hind legs directed to the sides and well forward, like a pair of oars, ready for the stroke which will send their bearer shooting off after some unwary prey. They are species of back-swimmers of the genus Notonecta (some smaller, more slender species belong to the allied genus Buenoa, which are distinguished by having the last segment of the antenna longer than the preceding, instead of much shorter, as in the more common genus Notonecta). Our commonest and most widely distributed species, *Notonecta undulata*, is milky white in color, with black spots and bands and red eyes. They spend much of their time hanging, head downward, just beneath the surface film, the tip of their abdomen in contact with the surface film and at such an angle that the tips of their middle claws also just touch the film. Others prefer to float about in the water, or in the shelter of aquatic vegetation.

Stroke!

Living streamline models

The habit of swimming always on their back sets these fellows apart as one of the most curious of insects. Upside down, they are in shape perfect boats, the middle of the back representing the keel: miniature submarines, with oars instead of propellers. Examine these great hind legs; they are flattened and fringed with long close set hairs; these spread apart under the pressure of the pulling stroke, and collapse on the return. The front and middle legs are spiny, somewhat pincer-like and used for holding their prey. If the creature gets out onto the land, it can pull itself along with these legs, or flop about with its hind legs, but none of its legs are very useful for walking. Its wings, however, tucked

Sea-legs ashore

away beneath the wing-covers are powerful and enable their possessor to fly from pool to pool when occasion arises.

Along each side of the belly there is a groove covered by a fringe of hairs. Along the sides of this groove are the breathing holes, and when the back-swimmer goes down into the water these grooves are filled with a bubble of air, held in place by the fringe of hairs, and serving as a supply from which it can breathe. When they stick their tails out at the surface of the water, it is in order to renew this supply of air, and careful watching will sometimes show them pressing out the air bubble with their hind legs. While carrying these bubbles around with them, they are lighter than water, and "fall up" to the surface if they do not either cling onto something with their middle feet, or keep vigorously "rowing" with their oar-feet.

Like a diver's suit

Falling up!

The eggs of one common species are inserted into slits which the mother makes in the stems of water plants. Others glue their eggs to any object under the water. The eggs are laid in the early spring and again later. The young look like miniatures of their parents, but are wingless, of course. They are greenish white with pink eyes. Wings develop gradually and there is no resting stage (pupa) as these insects are true bugs (Hemiptera) and have incomplete metamorphosis. In about forty days they are full grown.

Adult back-swimmers pass the winter hidden in the mud or debris of deep pools, or in open spring-fed pools, or remain more or less active all winter, even swimming around under the ice. They are very interesting to keep in aquaria, and can be fed on flies or other insects, but a cover should be kept over the aquarium, for when they rise to the surface and turn over back uppermost they can leap into the air from the water and fly away. They

capture and feed on insects larger than themselves, and even fish. With the short little beak which lies between their front legs they can also give one's finger a wicked sting.

Ouch!

Fig. 27—*A back-swimmer*
2 times natural size

Fig. 28—*A water-boatman*
2 times natural size

Pardon, mistook you for Miss Notonecta

No other insect is likely to be mistaken for back-swimmers except water-boatmen, (Corixidae) which look somewhat like back-swimmers, and have rather similar habits, also using two of their legs as oars. *But water-boatmen are smaller and never swim on their back.*

6 (*b*) *Whirligig-beetles.* (Family Gyrinidae; order Coleoptera). *Demonstrate a peculiarity of their eyes.*

What scout does not know the oval black beetles that go darting about over the surface of any creek or pond, in all parts of the United States? In the south he may know them as "vanilla-bugs," on account of the vanilla-like odor that is given off by a milky secretion that comes from their joints when they are caught; in other places they are called "dishwashers." With enviable skill they dart about over the surface, here, there and everywhere, as gracefully as the best of skaters. Catch some—a quick swoop with a water net is the best way, although of course you *can* catch them in your hands—and see how it is that they can go so fast. Their middle and hind legs are short and flattened and very broad, making four perfect paddles, but altogether useless for walking

Side-paddle ferry-boats

if they should get onto the land. Their front legs are long and useful for grasping objects. If hard chased a whirligig-beetle will dive beneath the surface, but usually stays on top. Put some in a dish of water and keep them alive for a few days, covered with a glass or a cloth so they cannot fly away, for they have strong wings tucked away under their wing covers. Notice their attitude when at rest, their manner of swimming, how they behave when frightened, how they keep down under water when they want to, and how they come to the surface again. When they are swimming on the surface it is useful for them to be able to look down into the water, and at the same time up into the air. Look carefully at their head and see what arrangement of eyes permits them to do this. There are two kinds of whirligig-beetles. The little ones, measuring less than one-third of an inch in length, and which have a small triangular piece of their back showing at the base of and between their wing covers, are called Gyrinus. The large ones, over one-third of an inch and usually over half an inch in length, and without any piece between their wing covers, are of the genus Dineutes. The largest kind of Dineutes lives in northeastern Georgia.

Four-eyes

Fig. 30 — *Side-view of head of whirligig-beetle, showing upper and lower eyes*

Little and big

Young whirligig-beetles, the larvae, live under water and are not often found. They look, as Dr. Lutz says, like little centipedes, but only the first three segments bear legs, and what at first sight look like legs along the sides of their bodies are really gills. They crawl out of the water and spin a well-hidden cocoon among plants growing near the water. The adults live over winter, and come out sometimes during warm spells for a mid-winter swim.

6 (*c*) *Water-striders.* (Family Gerridae; order Hemiptera).

Fig. 31—*A water-strider, Gerris*

An aquatic meet

Themselves at home in the water, good scouts count as fellow creatures the long-legged water-striders that go scuttling over the surface of their swimming-hole, or congregate in groups in an eddy. On almost any body of water, still or swift, one may find them, anywhere in the United States.

Walking on water

They are not lighter than water; then how can they walk over the surface? If you very carefully lower a needle onto a dish of water, it will float on the surface, but once let it get beneath the surface and it will sink like a shot. It is due to the tension of the water at the surface, which forms there what is called the "surface-film" and prevents small objects from breaking through without distinct effort. Put a water-strider in a white dish filled with water, in the sunlight. Notice that its body does not touch the water and only four of its legs do so. Where each leg touches the surface-film it presses it in a little ways, making a sort of dimple, and the round shadow of this dimple may be plainly seen on the bottom of the white dish. Why is it surrounded by a ring of light, unlike the shadow of the body?

Shadows

How?

How do the water-striders move around? For what purpose do they use their middle legs? Their hind legs? Have you seen them eat? Drop a dead fly on the water and see if they do anything. Have they a beak? How do they use it? Will fish strike at them when they see them on the surface?

The eggs of water-striders are fastened with a waterproof glue to floating grass or other objects near the water-line, often in regular rows. They hatch in from ten days to two weeks; the young are like tiny editions of their parents, and jump about in a very lively fashion. They shed their skin five times before they become adult, which takes in all about a month or a little more. Only a few individuals, however, acquire wings, even when adult. The distinguished possessor of wings is enabled to fly to other pools, should the one on which she is living dry up, which her wingless sisters cannot do. In this manner in times of drought danger to the perpetuation of the species is avoided. There are also sometimes found individuals with wings so short as to be useless for flight.

Spider-like babies

The adults live over winter, hiding under rubbish along the edge of streams.

Under the snow and ice

Water-striders live in all parts of the United States. For distinctions between some of the kinds of water-striders see paragraph 17E on page 190.

7 (*a*) *Carrion-beetles.* (Family Silphidae; order Coleoptera).

If one turns over the decaying carcass of a dead animal—a small one, such as a snake, bird, fish or mouse, will not be so unpleasant a task as if the carcass should be of greater size—he will almost certainly observe one or more large beetles beneath it, or in the grass round about, or poking its head out of some cavity in the carcass to see who has disturbed it. Omitting many kinds of *little* beetles, the big ones, about an inch or more in length, will be of one of three kinds. They may be long and slender, with wing-covers very short, leaving the abdomen uncovered, in which case they are "rove-

Hold your nose!

A ghoul's bouquet

Rove-beetle

beetles,'' or as they are often called ''devil's coach-horses'' (Family Staphylinidae). They may be board, oval and rather flat, dull black in color, or brownish, and some kinds with a yellow spot on the thorax. These are carrion-beetles of the genus Silpha.* Finally they may be carrion-beetles, but of the genus Necrophorus,* which are big, strong black beetles with large orange blotches on them. The flattened shape of Silpha enables them to slip beneath the carcass. The larvae live also in the carcass, and somewhat resemble sow-bugs.

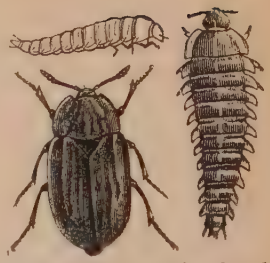


Fig. 33—*A carrion-beetle (Silpha inaequalis) and its larvae*

Fig. 34 — *Another carrion-beetle (Necrophorus americanus)*

Undertakers

European species of Necrophorus have the habit of digging holes beneath the carcasses of small animals, laying their eggs in them, and covering them with earth. Writers in America seem to have assumed that our own species have the same habit, but so far as I know it has never been actually observed here, on the contrary they have been observed to live in the carcasses on the surface of the ground without any attempt at burying them. If any scout in North America observes any of these beetles actually burying a dead animal, he will do a very good turn if he writes to the author of this pamphlet and tells of the

A chance for fame

* If you wish to distinguish the different kinds of Silpha and Necrophorus, turn to paragraph D on page 193.

instance and sends a specimen of the beetle, so we can see what *kind* of Necrophorus it was. This record will be published under the scout's name.

Carrion-beetles live in all parts of this country.

7 (*b*) *Tumble-bugs.* (Canthon; family Scarabaeidae; order Coleoptera).

Fig. 35—*Tumble-bugs, Canthon, rolling a ball of cow-manure*

A game of push-ball

Throughout the south and along the Atlantic Seaboard the dull greenish beetles that roll along little balls of cow-manure are familiar enough to everyone. The habits of our American tumble-bugs have not been closely studied, but they may be inferred from the habits of European species which engage in similar labors. They bury the balls which they roll, and probably reconstruct them below ground, laying an egg in each. Observe how well fitted is the shape of their front legs both for digging and for this type of pottery work.

The scout who wishes to study tumble-bugs should begin by reading at least the four chapters on "The

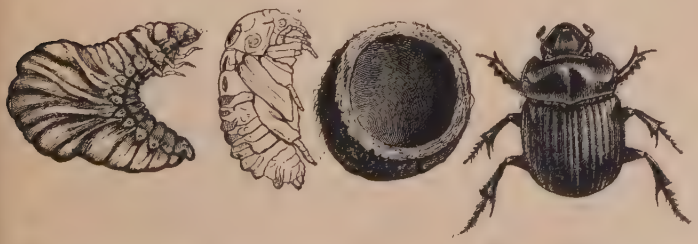


Fig. 36—*Another tumble-bug, Copris carolina, with its larva and pupa, and the cell, cut open, in which the latter live.*

sacred beetle" in The life and love of the insect, by J. H. Fabre, (See the Bibliography, page 171, item 27) a work which is in most libraries. The following chapters are about other related kinds of dung beetles. Thus one may obtain many suggestions as to the probable habits of our own species, and, if so inclined, can discover facts about them. which if made known will be of real interest to entomologists.

The distinctions between several of the kinds of tumble-bugs is indicated in paragraph L. on page 197.

7 (*c*) *Leaf-beetles.* (Family Chrysomelidae; order Coleoptera).

Lady-bug or leaf-beetle?

There are very many kinds of leaf-beetles, living on and eating the foliage of nearly all kinds of plants. Some of the common kinds look like lady-beetles, but may be distinguished in the following way: the hind leg of the lady-beetle has *three* little short joints at its end (tarsal segments) while the leaf-beetle has four, and the feeler of the lady-beetle is club-shaped, thicker at the tip, (see figure 38) while that of the leaf-beetle is thread-like. We can describe below only a few kinds.

Fig. 37—*A leaf-beetle, Octotoma plicatula. Enlarged*

Fig. 38—*Feeler of a lady-beetle*

Potato-beetles
(*Leptinotarsa decemlineata*)

The Colorado potato-beetle is a very common kind of leaf-beetle. On any potato-vines you can find the beetles, the reddish fleshy grubs, and the orange oval eggs, the last set on end in a patch.

The genus to which the Colo-

Fig. 39—*Potato-beetle. Enlarged*

rado potato-beetle belongs occurs in greatest abundance in southern Mexico and Central America and it is supposed that this species originated in that region, where now it is represented by closely related forms. It, however, migrated northward so that by the early part of the last century it occupied a strip on the eastern slope of the Rocky Mountains from Texas and New Mexico northward to the Canadian boundary. The potato-beetle was first described by Thomas Say in 1824 from specimens collected in the upper Missouri River Valley. The original food plant of the insect was the buffalo-bur, *Solanum rostratum*. When the easrly settlers first began to plant potatoes in western Nebraska, the beetles discovered in this new plant a food greatly to their liking. In 1895 the beetles were feeding on potato about one hundred miles west of Omaha in Nebraska. This marks the beginning of the rapid and destructive eastern spread of the species. The Missouri River was crossed about 1861 and the Mississippi by 1864. The main line of advance continued around the south shore of Lake Michigan, across Illinois, Indiana and Ohio, down through the natural highway of the lower Great Lakes through Ontario to the Province of Quebec and through Pennsylvania and New York and into New England. The Atlantic Coast was reached in 1874. In the early part of this great migration, the beetles averaged less than fifty miles a year, but after crossing the Mississippi River the yearly advance was considerably greater and the whole distance was covered at an average rate of about eighty-eight miles a year.

The onward sweep of savage hordes

Slower than a tin lizzy

"It is now difficult to realize the apprehension with which the farmers viewed the coming of the potato-beetle. Spraying was then unknown and arsenical poisons had not yet been used for the control of injurious insects. Although the value of paris-green for the destruction of this pest was demonstrated in 1869, suitable apparatus for its application was not to be obtained. The first dusting and spraying machines were crude, clumsy and inefficient. If one considers the enormous hordes in which the beetles appeared and the completeness with which they defoliated the plants in the newly infested areas, some idea can be gained of the

The terror-stricken countrymen

serious situation that confronted the potato-growers of this period.

A relentless march through a prosperous land

"In the newly occupied territory the beetles found few of their natural enemies and, therefore, for a time multiplied unchecked. In their eastward advance they moved through a region which was thickly settled, where their food was grown in great abundance and in a climate to which they easily adapted themselves. They were aided in their rapid advance by the prevailing west and southwest winds during the season when the beetles were on the wing. The rapid spread of the Colorado potato-beetle across the eastern United States has had no equal in historic times, except possibly in the case of the recent advance of the cotton boll-weevil through the cotton-belt of the southern states.

"After reaching the Atlantic Coast in 1874, the potato-beetle gradually extended its range southward east of the Appalachian Mountains, but northern Florida was not invaded until about 1900. The advance down the Mississippi Valley had also been slow and the beetles did not appear in central Louisiana until about the same date. The potato-beetle is now generally distributed east of the Rocky Mountains from Montana to New Brunswick and Nova Scotia and southward to northern Florida. It also occurs in New Mexico and Arizona and in Idaho, Washington and Alberta. Where the potato is not available for food, the beetles will sometimes attack eggplant, tomato, pepper and even tobacco.

The whole country conquered!

"The potato-beetle hibernates as an adult sometimes under rubbish, but more frequently in the soil at a depth of several inches. The beetles emerge from their winter quarters in the spring just before early planted potatoes come up. At this time they will feed on pieces of seed potatoes left on the surface and will sometimes dig into the soil in search of the tender sprouts. They feed for a time on the tender foliage and then, after pairing, deposit their eggs on end in masses on the underside of the leaves. The female is capable of laying from 200 to over 1800 eggs with a probable average of 400 or 500. The eggs do not ripen continuously, but in successive batches; all the eggs which ripen at a given time may be deposited in one or more clusters. The

average length of the egg-laying period in the field is probably between four and six weeks, but under cage conditions the beetles have continued to lay eggs for ten weeks or more. The eggs hatch in four to nine days.

Fig. 40—*Larvae of potato-beetles, feeding*

On hatching, the young larva begins at once to feed on the leaves. In the course of its development the larva passes through three or four stages. The larvae become full-grown in ten days to three weeks and then enter the ground to a depth of several inches where they transform in earthen cells to pupae. The beetles are often called hard-shells to distinguish them from the larvae, which are known as slugs or soft-shells. After feeding a few days, the beetles may either go into the ground for a more or less extended period of rest or they immediately lay eggs for a second generation. Owing to the long period over which egg-laying takes place, all stages of the insect may be found at times during the latter part of the summer. There are normally two generations produced annually, but in some cases a small third brood of larvae may develop and in Montana it is claimed that there is only one generation." (Crosby and Leonard. Manual of vegetable-garden insects.)

Flea-beetles

"Among the most troublesome of garden pests are several species of small, usually dark-colored leaf-beetles which have the hind femora* enlarged for jumping. When alarmed they spring suddenly into the air to a distance of a foot or more and thus escape the pursuer. This habit of jumping has given the insects the highly appropriate name of flea-beetles. Flea-beetles, as a rule, eat out pits or holes in the leaves, causing the death of the surrounding tissue. Badly injured leaves become riddled with holes, turn brown and die. The beetles are most destructive to young plants early in the season. In most species the larvae feed on the roots, but in some cases they may live as miners in the leaves or as borers in the petioles. Usually the beetles hibernate in dry sheltered places, under the bark of trees, under rubbish and in hedgerows. It often happens that their injuries to cultivated crops are first apparent along the edge of the field nearest to such shelter. Some species are closely restricted to one or two food-plants, while others attack a large variety of plants in widely separated families. As a rule, however, each species shows a decided preference for some particular group. For instance, one prefers the cabbage, turnip, mustard and their relatives, another is more or less restricted to the potato and other solanaceous plants, while a third is partial to the beet, spinach, lamb's quarters and others of the same family." (Crosby and Leonard. Manual of vegetable-garden insects.

Fig. 41—*Three-spotted flea-beetle, Disonycha triangularis*

Fig. 42—*Spinach flea-beetle, Disonycha xanthomelaena*

* The femora are the first long segments of the legs.

Cucumber-beetles
(*Diabrotica*)

The striped cucumber-beetle (*Diabrotica vittata*), yellow with three black stripes, occurs everywhere except in the far west where it is replaced by another species (*Diabrotica trivittata*) that looks almost like it, but is a little darker and has its feelers and legs mostly black instead of yel low. The twelve-spotted cucumber-beetle, the larva of which is also called southern corn root-worm, or corn bud-worm (*Diabrotica duodecimpunctata*, which is latin for twelve-spotted diabrotica) occurs everywhere east of the Rocky Mountains and is one of the commonest of all beetles on all kinds of low plants. It is recognized by its *green* color and twelve black spots. On the Pacific Coast it is replaced by the equally common western twelve-spotted cucumber-beetle (*Diabrotica soror*) which differs by having its under side and legs black. The young of all of these beetles bore into the roots of the plants.

Fig. 43—*Striped Cucumber-beetle, Diabrotica vittata, 2 times natural size*

Fig. 44—*Twelve-spotted cucumber-beetle, Diabrotica duodecimpunctata. 4 times natural size*

Larva

8 (*a*) *and* (*b*) *Ants.* (Family Formicidae; order Hymenoptera).

Often, when turning over a stone, one uncovers an ant's nest and watches the ants scurrying away to cover.

Many of the ants are apt to be carrying little white or brownish objects with them, in their mad dash for safety. Most folks know these things as the ants "eggs," but that is just about as wrong as it could be, for instead of eggs they are baby ants—larvae or pupae as the case may be. Little groups of the eggs themselves may also have been uncovered by the stone, but they are very tiny, no bigger than a pin's point. The ants are much more concerned with the safety of their children than with that of the eggs.

Eggs or babies?

The ants disclosed when one breaks into a nest, and that grab up the young and go scurrying away are called workers. It will be noticed that they have no wings. It is a strange fact that among ants there exist not only males and females, but also a third sex, or more properly caste, the neuter, which includes workers of different kinds and soldiers. In reality this worker is a sort of female which never develops sexually and which differs in form, size and appearance from the true egg-laying females.

The poor working folk

Males, females, and neither

SEX OR CASTE		WINGS	HEAD	THORAX	WORK
Male		Has them	Small	Large	Its only use is to mate with the female, after which it soon dies.
Female*		Has them but casts them off later	Large	Large	Mates and does all the egg laying. Founds a new colony and raises the first brood herself. Thereafter does none of the work.
Neuter	Worker minor	None	Large	Small	Gathers food, fights, cares for nest, eggs and young.
	Worker major	None	Larger	Small	Same as worker minor.
	Soldier	None	Very large	Small	Fights and guards nest.

* Queens are females which have begun to lay eggs.

The relations of the different kinds of ants in a colony to one another, and also their differences are shown in the preceding table:

The males and females have wings, while the workers have none. This explains a question that often puzzles folks: Why do some ants have wings and swarm through the air and others live in the ground? Fact is they don't, or not exactly. The flying ants are the males and females off on a honeymoon. They have come out of the nests, but in the nests the more conspicuous and infinitely more numerous kinds are the wingless workers.

Big chested guys

Notice that the males and females, which have wings have also a large thorax, while the workers, which have no wings have a small thorax. What is the connection? Just this, wings are born on the thorax, and when there are any the thorax must be big so as to hold large wing muscles; when there are none, it can be small.

Many winged males and females develop in a nest, and suddenly some day when the weather just suits they all come trooping out and fly off into the air. The curious thing is that on exactly the same day out come the young fellows and shy little lassies from all of the colonies of that kind of ant in the whole neighborhood, swarms and swarms of them, and straightway they all go a-courting, and each, when he has found his mate, goes flying away with her on a honeymoon flight, and the whole air may seem to be filled with flying ants. It doesn't last long though, for soon they fall to the ground, the male to die, for his only use in the world has been accomplished, while for the female life is really just beginning. Her first act is to break off her wings for thereafter she will live underground, will never fly again, and wings would be in her way. Next thing is to search out a suitable place in which to start a new colony. Burrowing into such a spot, whether in the ground or in dead wood, she makes a little cell, and seals herself up from all contact

Stepping out

Setting up housekeeping

with the outside world. Then begins a long fast of many months, during which she brings up her first brood of young, tending their every want without any help, but most wonderful of all, not only does she take no food herself, but she *feeds her entire brood of babies* entirely from her own surplus fat, and with food derived from the breaking down of the huge wing muscles, which she will never again need. When full grown this first brood of workers is much smaller than usual. They relieve their proud mother, now become *queen* of the colony, of all further labor, and she retires to a secluded life with no activities except eating the food that is brought to her, and laying thousands of eggs.

A living nurse-bottle

Queenie

One may naturally wonder, why with this life-long duty of incessant egg-laying ahead of her (and her active life may continue for several years) she has seen fit to dispense with her husband. The fact is that her body is provided with a storage reservoir, where the sperm cells contributed by the male are stored through all the rest of her life, and fertilize each egg in turn as laid, nor does the supply ever have to be renewed. The queen is kept in her royal chamber, surrounded by her "ladies-in-waiting," who tend her every want with much solicitude, feed her, and lick her clean. A queen ant may be told from a worker by her much larger thorax, and is usually of much larger size.

The royal court

The newly hatched first brood workers dig a passage to the outer world, and begin to gather food for the entire colony, and this continues to be one of the chief jobs of all their kind. But equally important is the care of the young. The eggs when laid by the queen are carried away by the workers and massed in bundles; the eggs are sticky on the outside, which causes the bundle to hold together. When hatching, one nurse holds up the bundle, while another feeds those which have broken the shell. The larvae when young also hang together

Quarter-masters

Also nurses

by means of tiny hooked spines. Thus the nurse can carry around many young larvae or eggs in a mass, at one time.

Young crooks!

The larvae are white, shaped like crook-necked squashes, the small end the head and very extensile neck. By feeding some more than others the nurses keep all of a size, regardless of just when they were hatched, and they keep those of different sizes in different nurseries, reminding one, as Mrs. Comstock suggests, of graded schools.

Hospital style.

The young larvae are fed with food which is regurgitated from the mouth of the nurse, but as they grow older more substantial food is brought to them and they do their own eating. The nurses are very particular about temperature and draughts for their charges. In underground nests they carry them down into deep chambers during the heat of the day, and bring them up near to the warm surface stones in the cool of the night. They carry them about with their jaws, which are very powerful, and the ants' universal tool-of-all-work, but they handle them very tenderly, and when they have reached the pupa stage they hold onto the cocoon covering, as though carrying a baby by its clothes.

Callow youths!

Ants, unlike white-ants, have a complete metamorphosis, and when the larvae are ready to become pupae, they either spin a cocoon around themselves, or just transform into naked pupae without any cocoon, according to the kind of ant that they are. When they are ready to become adults, the nurses help them carefully out of their cocoons or out of their pupal skins. When first out they are whitish, with black eyes and are called "callows." They don't know anything, don't have sense enough to take care of themselves or know where to go, but have to be carefully taught by the nurses. The nurses pick them up in their jaws, and carry them

about, the callow often curling up like a kitten. Sometimes the callows are herded together in a mass, the nurses standing around them in a circle. By and by the callows acquire the colors and learn the wisdom of their fellow workers.

Tenderfeet

Among some kinds of ants all workers are alike. Among others there are certain workers of larger size and with much larger heads, which are called worker majors. This is true among the carpenter ants. Then there are other kinds among which exist a small number of individuals with gigantic heads and huge jaws. These individuals are soldiers, and never take part in the household work of the colony.

The swell-headed military crowd

The five end segments of an ant's antenna enable her to smell. But what smellers! The last segment enables her to catch the odor of her own nest and recognize it from another, the next segment catches the smell of any sister ant, that is a member of her own colony, so she can tell the home folks from strangers, the next segment catches the odor of her own feet on the trail, so she can follow her own back track if need arises; the eighth and ninth segments convey to her impressions connected with the care of the young. If these five segments are cut off from the antennae, the ant is no longer capable of doing her work, and becomes a useless and helpless member of the colony.

Some smellers!

One could write indefinitely about ants, and when it comes to the habits of the different kinds (there are thousands of different kinds) there are so many astonishing things to be told, and for that matter still to be discovered, that many interesting books have been written about them. One of the best and most authoritative of these is Ants, their structure, development and behavior, by W. M. Wheeler (See Bibliography, page 172, item 36). It is somewhat technical in treatment, but many of the

chapters reveal really marvelous facts, which make one forget and forgive the big words. A more readable account is by Dr. McCook (See page 172, item 35). Further information about ants is also given on pages 102 to 112 of this work, under the discussion of requirement No. II.

8 (*a*) *Carpenter-ants.* (Camponotus).

In our northern woods one continually encounters large black ants which run about over the tree trunks, and which seem possessed to climb over us whenever we sit down on the ground. Some are all black, others are black and reddish. They are carpenter-ants. The black and reddish northeastern kind bears the astounding name of *Camponotus herculeanus ligniperdus novaboracensis,* which is about a record when it comes to a tongue-twister. One kind or another lives wherever in North America there are woodlands. They nest in dead wood, which is often completely riddled and honey combed by their chambers and galleries. The pupae of these ants are enclosed in silken cocoons. The workers are of two forms, some small with moderate sized heads, others larger with big heads. There are no real soldiers.

Fig. 46.—*Carpenter-ant. A female that has lost her wings. Greatly enlarged*

Tongue-twister

In Florida and along the Gulf Coast there lives a kind of carpenter-ant which is called bull-dog ant. They are yellowish in color with darker heads, and are very vicious biters—hence their name. They live in very dry decaying logs.

Bull dogs

8 (*b*) *Agricultural ants.* (Pogonomyrmex).

Very familiar to any one living in the region of our western plains or deserts are gravel mounds built by ants, and surrounded by extensive areas cleared of all vegetation. They are the homes of agricultural ants, or as they are sometimes called, mound building prairie ants. One species lives in Florida.

Big business

These mounds cover a very busy ant-city, for in a prosperous colony there may live ten thousand and more workers. Their galleries and chambers penetrate deep into the earth, often ten feet or more. Many of the chambers are nurseries, others are used by the adults as working and living rooms, while still others are granaries, where seeds of certain plants are brought in and stored. Some of these granaries are full and sealed for future use, others may be open and in process of being filled, or in use as a pantry.

Where the pies are kept

The top of the mound is covered by moderately coarse pebbles or other material gathered from the neighboring ground. Beneath this is a layer of fine earth carried up from the galleries of the nest, cemented together so as to form a waterproof roof. One or several openings are made for entrances. At night a small group of workers close these, but if an approaching storm gives need of haste, a whole lot more workers come out to help them. The openings are closed with small pebbles or other coarse material, so cleverly that one cannot tell where the opening has been. The gates are closed about sunset, and opened between 8 and 9 in the morning. Then out swarms the day's working force, to begin the clearing away of vegetation, the harvesting of seeds or the reconstruction of the surface of the nest.

Locking up for the night

Regular farmers

They gather the seeds of certain kinds of plants and carry them into the nest. There they thresh them with their mandibles, carry chaff outside and pile it up at

one side of the nest. They do not intentionally plant seed, as some fŏlks have thought, but seeds carried out with the chaff, grow up about the chaff piles, so that they often give the appearance of a little planted garden of their favorite grain at the edge of their nest.

Union hours

On hot days the working force returns to the nest before noon, and remains inside until the hottest part of the day is passed, then comes out again and works until evening. On cool days they stay out all day.

The agricultural ants are of reddish-yellow color, some kinds reddish-brown. There are several species, but the distinctions are technical. Between the abdomen and the thorax are two swellings, while the carpenter-ants have only one. The workers and queens can sting, while the carpenter-ants cannot, and the pupae are not enclosed in cocoons like those of the carpenter-ant. For these (and other) reasons the agricultural ants belong to a different subfamily from that of the carpenter-ants.

8 (*c*) *Black-fly larvae*. (Simulium: family Simuliidae; order Diptera).

Where the current is rushing to the brink of water falls, one may often notice black patches on the rock, caused by the presence of dense masses of soft and bag-like cylindrical black larvae. These are young black-flies. They are perhaps the most widespread and characteristic animal of running water. One may also often find them attached to any object held in the swiftly running current. They hold on by means of a disk-sucker at their tail end, and their head floats downstream, but they also spin a loop of silk around themselves and fasten it to the rock, as additional support against the strong current. By means of these two hold-fasts they can move about over the rocks. In doing so they loop their bodies like a measuring worm or leech. Just behind their head is a single fleshy leg, which is useful in manipulating

Hold tight

Fish and feast

Straining the soup

the thread of silk as they spin and place it. Hanging head down current, they expand a pair of fan-like strainers which they possess, one on either side of the head, and catch the microscopic life that comes floating down with the current, then draw in the fans and feast on the catch. "There is little movement from place to place," write Needham and Lloyd. "The larvae hang at full stretch, their pliant bodies swaying with little oscillations of the current, their fans outspread, straining what the passing stream affords. Each of these fans is composed of several dozen rays, each of which is toothed along one edge like a comb of microscopic fineness, and all have a parallel curvature like the fingers of an old-fashioned reaper's cradle. They are efficient strainers."

Fig. 48—*Pupa of black-fly*

Horns

When grown the larvae spin yellowish cocoons in the very place where they have been living, and turn to pupae within them. The pupae have a pair of branched "antlers," which, however, are in reality tube-gills.

Consarn that pesky fly

The adult fly is a hump-backed little fellow with a great fondness for exploring around one's neck and ears, or between one's fingers for a suitable place to bite. Those who are about the woods in the north in black-fly season are all too familiar with them. They lay their eggs at the edges of streams, just where the water will lap over them from time to time. In the south and middle west they are perhaps better known as buffalo-gnats.

Fig. 49—*A black-fly*

8 (*d*) *White-ants or termites.* (Order Isoptera).

White-ants occur commonly from New Jersey and Pennsylvania southward and westward to the Pacific Coast, but are not so common in the middle west, nor in the north. They are to be found under stones or in dead logs, and frequently tunnel into posts, poles and all sorts of wood work, causing great damage. In dry and desert regions of the west, various kinds live in such places as cactus roots and stems, especially the dry woody ribs of giant cactus, in ocotilla, in the roots and stems of sage brush, under chips of cow manure, in dead flower stalks of century plants, in dry wood of cottonwood and palo verde, etc. In Kansas they are abundant in heavily sodded prairie. They are not ants at all, but are called ants because folks have mistaken them for true ants on account of their ant-like habits.

Society bugs

Termites, like ants, are social insects. They live in families of thousands of individuals altogether in one nest or colony. Termites have incomplete metamorphosis, therefore the young nymphs, when hatched, resemble the adults, but have no wings. These nymphs are of several kinds, and are milky white in color. One kind becomes dark in color, and develops both wings and eyes. They will form the kings and queens of new colonies. All the others remain more or less white, and never develop either wings or eyes. One of these kinds

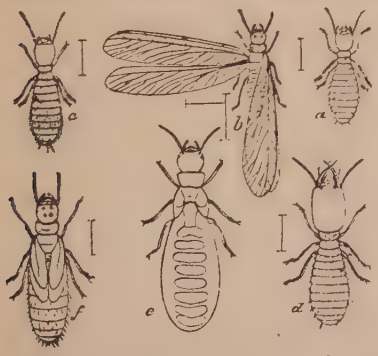


Fig. 50—*White-ants or termites*
a. Young
b. Winged female
c. Worker
d. Soldier
e. Queen
f. Young with wing-pads

King, Queen, Workmen and Soldiers

develops into males and egg-laying females, which, however, are wingless and never leave the nest. Another kind develops into workers, which remain soft and white, have small heads and jaws, and perform the labors of building galleries, runways, etc., and caring for the young. They are by far the most numerous kind. Finally there is a kind which develop into soldiers, which can be told by their big brown heads and jaws. Their purpose is entirely that of defense.

A great hulabaloo

One day in the spring or summer there is liable to be a great commotion in the colony. Workers and soldiers are rushing around in excitement, and accompanying the thousands of newly grown winged males and females to the nest entrance. There the winged ones are pouring out by the wholesale, climbing onto every eminence, shaking their wings, and finally sailing away in a swarming cloud. The same thing is going on at the same time in every other nest of the same kind of termite, and all these sailing clouds of termites will carry their kind to new places for nest building, and will mingle the strains of different nests. Many fall by the wayside, for the helpless creatures are an easy mark to the birds for a great feast. Others fall to the ground, and then proceed to deliberately snap off* their own wings, for they will never need to fly again. Each proud young buck then selects his life partner, and together they go off to start a new colony.

Dark passageways

The white blind termites dare not expose themselves in the open for any great length of time. In order to reach a proper food supply they sometimes build covered runways along the trunks of trees, walls of buildings, etc. These are made of chewed up wood and earth, cemented together by saliva. Sometimes in the tropics they hang suspended from the trees, connecting with

* The wings of termites have a thick stub at base, and beyond it a weak line, along which they are subsequently broken off, only the stubs remaining.

the ground. Such covered runways are commonly made by a certain species (*Amitermes tubiformans*) around grass stems and desert plants in western Texas.

9 (*a*) *Crane-flies.* (Family Tipulidae; order Diptera). In shady places in the southern states, northward as far as New Jersey, there may often be seen large slender flies, dancing up and down in a peculiar manner, rising two or three feet up into the air and as suddenly dropping again, continuing this rather silly performance until one would think that they would be thoroughly tired of it. The southern scout knows them as "weavers" (*Brachypremna dispellans* is their name) and they are only one of the many kinds of crane-flies which make up the family of flies known as Tipulidae. Nearly all large and slender flies with *very* long legs are crane-flies. Folks call them also gallinippers, and often think that they are huge mosquitoes. No real mosquitoes are so large, nor do they have such long legs, and mosquitoes always have fine scales on their wings, which crane-flies do not. Some crane-flies, however, are quite small, but all are very slender and have very long legs which drop off at almost a touch. Any such fly is almost surely a crane-fly, but to be very certain, one may look on the middle of the back of the thorax, between or just in front of the wings and if he sees there an impressed V-shaped groove, then it is a crane-fly for sure.

A shady dance

Fig. 51—*A crane-fly*

Many crane-flies are very abundant insects, especially in the north, wherever there are rich damp woodlands, which is the sort of place they most love. In drier, and more desert regions they are not so easily found and for that reason the scout living in such country may choose robber-flies in their stead. The most likely places to look for crane-flies are in dark spots about cliffs and caves, under over-hanging tree roots and banks, and in dark out-buildings, where they will be found resting. But they may also be found in numbers on the leaves of plants in rich damp woodlands and very often, especially toward dark, may be found swarming in the air. Since crane-flies *cannot bite at all,* (the only food they take is a little nectar from flowers), it is a good joke on a scout or grown-up who does not know much about insects to show him such a swarm of these mosquito-like creatures and hear him say "Gee! look at those mosquitoes, let's get away from here." But the real scout knows that he doesn't need to change camp just because the crane-flies are swarming around.

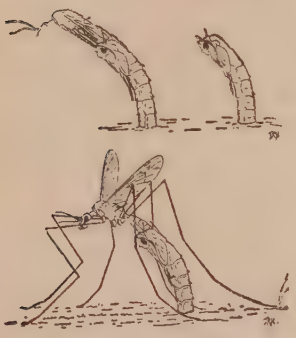


Fig. 52—*A crane-fly coming out of its pupa*

A joke on buddy

Young crane-flies are partly transparent, colorless or whitish grubs, often quite large in size (two or three inches long) with several sort of swollen rings around the body, and have at the tail end a funny arrangement of fleshy protuberances which once seen will enable the scout always to recognize their kind. They live in a great variety of situations, which have been listed by Alexander somewhat as follows:

Crazy looking grubs

List of Places where Crane-fly Larvae Live

1. In silk cases on stones usually in running water or rushing torrents, breathing by gills. Genus Antocha.
2. On submerged plants or in submerged moss.
3. Semi-aquatic: larvae in water, but pupae on the land.
4. On cliffs and wooden walls, usually in silken cases, covered by water.
5. In cold springs.
6. In stagnant water in the axils of certain plants.
7. In decaying wood, partly or entirely submerged in streams.
8. In mud or sand: (a) In swamps. (b) In shaded woods. (c) Along the margins of streams, ponds, etc.
9. In or beneath damp cushions of moss.
10. In dry soil.
11. In fungi.
12. In decaying vegetables, plant stems, manure and the like.
13. In wood: (a) In decaying wood, usually just beneath the bark. (b) In nearly solid wood.
14. On leaves of plants or mosses.
15. Mining in the leaves of plants.

The more sluggish larval crane-flies eat plant tissue, but some rapidly moving kinds are real hunters, and live on what animal food they can catch.

In the northeast, probably the easiest crane-fly larvae to find will be those of the giant *Tipula abdominalis*. They are common under accumulations of dead decaying leaves swept down by the currents of our woodland streams, and piled by them upon the bare obtruding roots of trees. They are stout, whitish, translucent legless grubs, two or three inches long.

Of a similar huge California species, *Holorusia rubi-*

ginosa, Professor Kellogg writes "The eggs are laid in the ooze of wet banks of little streams where fallen leaves are decaying, and sub-drainage water is always slowly trickling out from the soil. The larvae lie in this slimy bed, in crevices or on narrow ledges of rock, with the posterior end of the body bearing the two breathing-openings held at the surface. The soft ooze, composed of soil and slowly decomposing leaves is swallowed, and, as it passes through the alimentary canal, the organic material digested out of it. The footless worm-like larvae grow to be two and one-half inches long, but can contract to less than an inch. The duration of the larval life is not yet known, but it is at least several months. The pupae, which are provided with a pair of long, slender respiratory horns on the pro-thorax, lie motionless in the slime for twelve days, when the great flies emerge and fly up into the foliage of the stream bank." This species, called the giant crane-fly, is the largest of any kind of fly. Its body is nearly two inches long, and the spread of its legs four inches.

Slimy slush

Breakfast in bed

Why get up at all?

Scouts who want to learn about the different kinds of crane-flies, and the habits of each will find such information as is known in the works numbered 22 and 42 in the bibliography, pages 170 and 173. The author, Dr. C. P. Alexander, whose address is "Department of Entomology, Massachusetts Agricultural College, Amherst, Mass.," is the world's greatest authority upon crane-flies, and will be glad to give advice or suggestions to any scout who wishes to study their life histories. He is also willing to help interested scouts by naming specimens for them. It is quite within the power of any scout to add to our knowledge of these insects by carefully studying the lives of those of his own region. The life habits of the very common weaver of the south, for example, are unknown, except for the fact that the larvae live in wood.

A crane-fly shark

9 (*b*) *Robber-flies.* (Family Asilidae; order Diptera).

These large and ferocious-looking flies are common all over the country; there are many kinds, and they are very commonly as much as an inch and a half or two inches long, usually with long slender abdomens, with bulging eyes, and with bristly legs. When you see a big grey or rusty colored fly *sitting on the ground* or on the tip of a dead stalk, eyeing you intently, flying up suddenly when you come too close to please him, but alighting again a little way beyond, you may be pretty certain that he is a robber-fly. Perhaps you will discover him holding fast to some big strong insect, like a bee or beetle, with those spiny front legs, and busily sucking its juices. Then you will *know* that he is a robber-fly.

Tough customers

Fig. 53—*A robber-fly, Erax*

Watch him for a while, and maybe you will see him suddenly rise in the air and pounce on some unsuspecting victim flying by. See him swoop down with his powerful wings, so quickly that you hardly know what has happened, capture the luckless bee, and alight to suck its juices. His prize possession is a short, sharp and stout dagger, which he always carries beneath his head, bent slightly forward, and ready for an instantaneous thrust. This is his beak, and when you get to know them, you could almost surely recognize a robber-fly from his beak and head alone.

Help! Murder! Assault and battery!

The assassin's dagger.

Fig. 54—*The face and beak of a robber-fly*

Some robber-flies look different, are hairy and colored like a bumblebee. In fact, you almost surely will think they are bees, at first, so much do they look like them. If you ever see a bumblebee up and pounce on another insect, you will know, however, that it is not a bumblebee at all, but a robber-fly. That's the way they fool the bugs, looking so much like a harmless bumblebee that Mr. Bug gives no attention to them, until pounce! he's caught, and pays the life-penalty for his carelessness.* Others, not so fortunate as to look like bees, try a different trick. They flop over on their side, and lie still as though dead. Mr. Easy Mark Bug comes wandering along, and pays no attention to this dead body, until pounce! and he, too, is caught.

A murderer's disguise

Pretty tricky!

Fig. 55—*Larva of a robber-fly (above) feeding on a white grub*

The young stages of robber-flies are not well known, and it is improbable that the scout will find any, or be able to recognize them if he should. They are said to live underground or in decaying wood, and to live on such beetle larvae as they can catch, so they begin their murderous life at an early age.

An early training in crime

9 (*c*) *Damsel-flies and their nymphs.* (Order Odonata; suborder Zygoptera).

Hanging around a creek all day

Every scout knows the "darning-needles" or "dragon-flies" that fly about over ponds and creeks. Some scouts have observed that there are also smaller, more slender kinds, with weaker flight, that fly along the creek or shore, not high up in the air, but close to the water, and that alight on overhanging branches, or old snags along the shore. These are damsel-flies, and one may find

* The scout can definitely distinguish the bee by the fact that it has four wings, and jaws instead of a beak; the fly has only two wings.

Fig. 56—*A damsel-fly at rest*

them in summer wherever there are streams, or irrigation-ditches, or marshy spots anywhere in the United States. In marshy places they like to rest on the grass-stems. Damsel-flies may be told from dragon-flies by the fact that, when resting, they hold their wings parallel to their body, along their back, while a dragon-fly rests with its wings spread out, at right angles to its body. Adult damsel-flies feed on small insects, which they catch while flying in the air. Notice their large eyes, set on stalks on each side of the head, certainly well fitted to observe any creature flying anywhere in the vicinity. At the tip of her body the female has a little knife with which she cuts slits into plants under water and lays in each an egg. One may sometimes see her sitting on a stem, her abdomen immersed in the water, while she is thus busy laying eggs.

Sails furled

Pop-eyes

Fig. 57—*A dragon-fly, showing position of wings while at rest*

One would never suspect that the creatures which hatch from these eggs were young damsel-flies. They

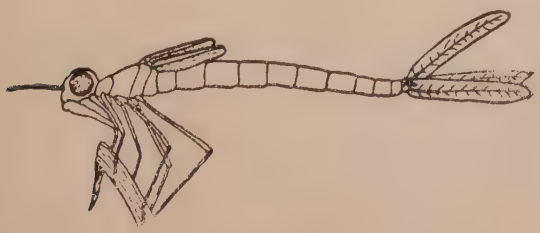


Fig. 58—*A nymph of a damsel-fly. Three times natural size*

Paddle their own canoe

can be told from any other water-creatures by the three big paddles which they carry at the tail end of their body. The illustration shows what they look like, and they can be found clambering about aquatic vegetation anywhere in the United States where there is quiet or sluggish water; little ditches and pools are fine places for them. Catch a few and put them in a white dish filled with water. After a bit put in some other good-sized soft-bodied insects, or even tiny minnows or tadpoles. Watch young Miss Damsel-fly suddenly prick up her ears, as it were, and bye and bye with a quick dart catch one. Over her face, when at rest she carries a huge mask, completely hiding it; and about as ugly and fierce-looking a face it is that she has to hide as one could well imagine. The mask is attached to a sort of bar that works on an elbow joint, so that it can either draw the mask up over her face, or suddenly shoot it out, stretching it away out in front of her, whereupon it reveals two sharp pincer-tongs that plunge into any prey she is after, and then the bar snaps back, carrying the mask again up over her face, and holding her victim fast right under her mouth where all she has to do is to chew it.

A masked villainess and an ugly mug

A quick thrust and a murdered victim

Then chew, and chew and chew,

Young Miss Damsel-fly likes to conquer the biggest victims that she can. If you place some sand in the bottom of her dish and some water plants in it, and feed her from time to time with living water-insects, you can keep her alive a long time, maybe until she is ready to crawl up some stem out of the water, split her skin and become a winged damsel-fly. Only be sure to provide her with such a stem, so she *can* crawl out of the water.

Growing up

How does the young damsel-fly swim? Does it use its paddles? Just for fun, and by way of comparison, catch a young dragon-fly (which looks a good bit the same, but is stouter and has no paddles at the end of

its tail). See if you can discover how it swims. Take a fountain pen filler and leave just a drop of ink in the water right back of its tail, then startle the creature, and see if you can get any clue from the water currents as to how it moves.

A clever swimming stroke

10 (*a*) *The caterpillar of a cabbage-butterfly.* (*Pieris rapae;* family Papilionidae; order Lepidoptera).

One has but to step into a garden to find cabbage-worms, which are the young of cabbage-butterflies. The number of generations per year are determined by the length of the warm season. In the northern states there are not more than three. Pale green eggs are deposited on either side of a cabbage leaf. When the baby caterpillar hatches the first thing it does is to eat its own empty egg shell. Then it begins to eat the cabbage leaf, eating out little areas on the under sides of the leaf. When ready to molt it first fastens itself with a few silken threads to the leaf and has to wiggle and writhe around a whole lot before it can get its head out of the old skin. After the second molt the caterpillars move about more and feed mostly on the edges of the leaves. When they are ready to molt for the fifth time they begin to crawl about hunting a favorable place in which to rest as chrysalids. They may choose a cabbage-plant, but more often crawl away to a fence-post, building or tree. They fasten the tip of their abdomen by some silk threads to the wall or fence or whatever it is, and spin a girdle around their waist to serve as a support.

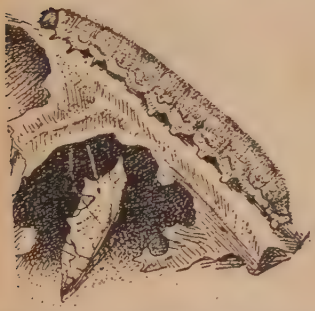


Fig. 59.—*A cabbage-worm and its chrysalis*

Eats its own egg shell

Then the body begins to shorten and thicken, and with much wriggling the larval skin is cast off, revealing the pupa or chrysalis. They overwinter in the chrysalis stage.

Fig. 60—*Cabbage-butterflies*

The female butterfly has two black spots on the forewing, the male only one.

10 (*b*) *The caterpillar of an alfalfa-butterfly* (*Eurymus eurytheme*; family Papilionidae; order Lepidoptera).

This occurs on alfalfa everywhere west of the Alleghanies, and sometimes is exceedingly abundant, especially in the southwest. The butterfly is yellow, with black wings and borders, otherwise resembling the cabbage-butterfly, and has similar habits and caterpillars.

10 (*c*) *The caterpillar of a monarch* (*Danaus archippus,* called also *Anosia plexippus;* family Nymphalidae; order Lepidoptera).

Neat but gaudy

Wherever milkweed grows, one may find, with a little searching, caterpillars gaudy with many narrow bands of black, yellow and white and bearing in front a long pair of black whip-lashes sticking up, and behind a

shorter pair. These are the caterpillars of the monarch butterfly. Their chrysalids, also found on milkweed, are very beautiful, of a bright green color, studded with spots of burnished gold. Monarchs do not overwinter in the north, but come up in the spring, and in the fall migrate southward in great numbers. Sometimes one finds trees along our southern shores where they congregate in flocks in the winter, basking in the sun, and enjoying life, quite like persons of fashion seeking their Palm Beaches.

The caterpillar of the monarch is distasteful, and his gaudy colors are a warning to birds to "lay off."

Birds, take warning

10 (*d*) *The caterpillar of a sphinx moth.* (Family Sphingidae; order Lepidoptera).

Tomato, potato, eggplant and pepper-plants throughout most of the United States and southern Canada often furnish food to other creatures than ourselves. Among these other creatures is a green to dark-brown caterpillar three or four inches in length with a greenish-white V on each segment and a green and black horn at the tail end. When you disturb one of these tomato-worms he may erect the front part of his body, draw in his head and remain motionless in this position for some time.

Fig. 64—*Caterpillar of the pen-marked sphinx, Sphinx chersis*

Other green or brownish horned caterpillars are often

met with on grape, ivy, ash and other plants, and they are all different kinds of sphinx-caterpillars. Any caterpillar with that peculiar horn on its tail, either stiff and curved, or more or less thread-like, may be recognized as a sphinx, although a few sphinx-caterpillars lack it. The catalpa-worm is in many parts of the southeast one of the most easily found sphinx-caterpillars. Southern scouts know that these make one of the best baits when fishing.

Got your bait?

Fig. 65—*The white-lined sphinx, Deilephila lineata*

Sphinx-moths fly mostly at dusk. They are often called humming-bird moths. At twilight one sees them come swiftly flying and poise in midair in front of a flower of honeysuckle, making a loud humming noise with their wings for all the world like a real humming-bird, while they uncoil their marvelously long tongue, thrust it deep into the tubular flower and suck its nectar. Catch a sphinx-moth, and notice this long tongue, how it is coiled up like a watch spring, and how very long it is if you uncoil it with a toothpick. It is easy for it to get nectar, from a vase-like flower-tube, when an ordinary moth would be helpless. If you raise a tomato-sphinx and dig up its chrysalis from the earthen cell which the caterpillar makes within which to transform, you will see that it has what appears to be a handle, like the handle of a jug. This is in reality the case in On hot summer nights in the south, and particularly in

Some soda water straw

the tropics one may find them sitting around on the telegraph poles that carry arc-lights, or on the ground or pavement beneath, their eyes reflecting a deep ruby flash of light. Never will the author forget the excitement of wonderful nights in the tropical mountain forests on the outskirts of Rio de Janeiro, collecting sphinx-moths at the arc-lights. Their variety and their abundance, and the thrill of finding each new specimen, matchless in its gorgeous livery, alive, its eyes flashing fire, its wings aquiver, suddenly come in swift flight from out of the mysterious jungle, carved deep and ineradicable impressions, that we rejoice to share with each and every scout who may read these lines.

The white lights of Broadway for the Sphinx

Jungle-nights

10 (*c*) *Tiger-beetles.* (Cicindela; family Cicindelidae; order Coleoptera).

Along a country road or beaten path in summer, or on a mud-flat or sand-bar, or along the beach at the sea-shore, one sees on sunny days alert beetles, that rise up as he approaches, flying swiftly ahead a few feet, and then realight, head towards the intruder, so they can watch his motions. They stand erect upon long and slender legs, ready to again take flight, and again and again, as one keeps coming up with them, until at last, wearied, they make a long detour and fly back whence they came. These are tiger-beetles, swift of wing, fierce and insatiate in their search for their insect prey.

Fig. 67—*A tiger-beetle (Cicindela limbata)*

Blood thirsty

The graceful form, the resplendent metallic-blue or green or coppery liveries of many species, variegated with buff dots and dashes or crescent-marks, have long given the tiger-beetles great favor among beetle-

Lovely

collectors. The species that live on the sea-shore or on white sand are often themselves white or pale in color, so that they can scarcely be distinguished from the sand on which they live. A small slender species with coppery elytra bearing lengthwise stripes of buff (*Cicindela lemniscata*) is very common in the southwest, and is attracted to the street-lights in large numbers, where it reaps a great harvest of victims.

Mrs. Comstock has written of the larvae as follows:

"The larvae of the tiger-beetles live in vertical burrows, which can be easily recognized after one has learned their characteristic appearance. These burrows abound in sandy places, in beaten paths, and in plowed fields that have become dry and hard. The larger ones, those occupied by full-grown larvae, measure about one-sixth of an inch in diameter, and often extend a foot or more in depth. The sides are smooth; the entrance to each is very regular in outline, and without any loose dirt on the surface of the ground near it, as is usually the case with somewhat similar burrows made by ants.

Fig. 68—*The larva of a tiger-beetle in its hole*

"Fig. 68 represents a larva of a tiger-beetle. When watching for its prey, the larva rests perfectly still at the mouth of its burrow. Its dirt-colored head is bent at right angles to its lighter-colored body and makes a neat plug to the opening of the hole. Its rapacious jaws extend upward, wide open, ready to seize the first unwary insect that walks over this living trap. On the fifth segment of the abdomen there is a hump, and on this hump are two hooks curved forward. This is an arrangement by which the little rascal can hold back and keep from being jerked out of its hole when it gets some large insect by the leg, and by which it can drag its struggling prey down into its lair, where it may eat it at leisure.

Hold tight!

"The holes of the tiger-beetle larvae are always open when found, the larvae being frightened away by the approach of the observer. But sit down near them, and watch quietly, and soon they will be plugged by dirt-colored heads. Each passer-by will cause the cautious larvae to retreat; but they will return in a few minutes to their position of patient watchfulness, and here they wait like a still fisherman on a log."

Timid

Mrs. Comstock in her Handbook of Nature Study gives further some excellent suggestions for studying the habits of these larvae which the interested scout should follow out.

11 (*a*) *Grouse-locusts.* (Family Tettigidae; order Orthoptera).

The little grouse-locusts, or pygmy locusts as they are often called, are not conspicuous insects, and although common enough have never been noticed by many persons, who if they have seen them at all have mistaken them for young grasshoppers. True enough they are grasshoppers, and always small, but not necessarily young. They are always brown or grey in color, and often mottled to look as though covered with lichens.

Dwarfs, but not babies

The best place to make their acquaintance is along the shore of a stream or lake. On mud-flats, wet sand-bars, and even among the stones you are sure to find them in numbers. Any little brown grasshoppers, half or three-fourths of an inch long that you find in such a place will probably be grouse-locusts, but one may make definitely certain by looking at the thorax. If the top of the thorax extends backward in a long triangular point reaching to the tip of the abdomen, it is a grouse-locust. Beneath this long point the wings of the adults are hidden, with only just their tips exposed. Take a pin and stretch out one of these wings and see what a pretty little netted fan it is.

At the old swimming-hole

Grouse-locusts occur in many other places, always on the ground, usually where the soil is very damp, because such soil is rich in their particular kind of food. They eat the surface clays and black muck consisting of vegetable mould, algae, lichens, mosses, etc. Notice that the particular kind of spot where any individual is living corresponds to its coloration, so that they are difficult to detect until they move. This fact protects them from their numerous enemies, such as spiders, toad-bugs, ants and many other creatures. When you attempt to catch them you will observe them leap with surprising agility, and very suddenly, almost invariably realighting on the ground, while the young of other kinds of grasshoppers usually alight on plant-stems, immediately dodging to the other side of the stem for protection.

Clay-eaters

Record high jumps

The adults hibernate over winter, and are the only northern grasshoppers that do this. "On the approach of winter they hide beneath chunks, chips, rubbish, the loose bark of logs, or beneath the bottom rails of old fences. Sometimes a warm sunny day in midwinter tempts them forth in numbers, and on such occasions the earth seems to swarm with them, as they leap before the intruder, their hard bodies striking the dead leaves with a sound similar to that produced by falling hail . . . On the first warm days of spring they can be collected by hundreds from any grass-covered hillside having a southern exposure, or from sandy places along the margins of lakes and streams." (Blatchley).

The females dig a little pocket in the ground into which in mid May, in our northern states, they insert their eggs. The young mature by fall, or some not until the next spring. In midsummer one finds chiefly young, for the last season's adults are by that time mostly dead, and the new generation are not yet mature.

11 (*b*) *Meadow-grasshoppers.* (*Orchelimum* and *Conocephalus;* family Tettigoniidae; order Orthoptera).

These are the slender bodied green grasshoppers with very long thread-like feelers which are so common in summer and fall in damp meadows and along the margins of streams, ditches and ponds. In such places, climbing among the grasses and weeds, countless thousands may be found.

Long horns

Fig. 69—*A meadow-grasshopper, Conocephalus*

The tip of the abdomen of the female is provided with a long sword-like instrument, in some kinds over twice as long as the rest of the body. This is not, however, a weapon at all, but is used for egg-laying, to pierce into the pith of twigs, or into the "pine-cone" galls on willows, or down between the stems and the root leaves of grass, and there to deposit the eggs. The eggs remain over winter, hatching in the spring. The young resemble the adults, but are wingless, and they undergo an incomplete metamorphosis. They molt five times, the last time acquiring wings, this occurring when the summer is well along.

And long swords

Not until they acquire wings do they begin to sing, for their musical instruments are on the wings. Only the males have these musical organs. Lift the upper wing-cover of one, look at its base, where it overlaps the other wing-cover, and you will see a rounded transparent place, crossed by a prominent curved vein, which on the under side bears a single row of minute file-like teeth. These are rubbed across a vein on the upper surface of the other wing-cover, producing the sound, while the transparent area acts as a sounding-board. Watch the males when they sing, you will see them slighly raise

Fiddle

Songs without words

their wing-covers, and move them back and forth across each other. Each kind makes a distinct call of its own, and one can learn to recognize them by their songs, just as he would a bird. Many kinds have a night song and a day song which are different. They may sing their night song, however, whenever the sun goes under a cloud.

Fooled by the sun

Ears on their legs

Both sexes have ears, located, curiously enough, one on each front leg. Each ear is a cavity covered with a transparent membrane, the ear-drum. The act of singing probably gives pleasure to the performer, who likes to show off in this manner before his lady love. She in turn doubtless finds such musical skill irresistible, and accepts his advances.

Serenading their queens

Note the way that a meadow-grasshopper keeps on the opposite side of the stem from your hand, moving around it so as to keep the stalk always between itself and you, just like a squirrel on a tree trunk. In doing this it hugs the grass stem closely, stretching out its long hind legs until they are parallel with the stem.

For methods of distinguishing meadow-grasshoppers from cone-headed grasshoppers and katydids, see paragraph 9, on page 183.

11 (*c*) *Katydids.* (Family Tettigoniidae; order Orthoptera).

There are many kinds of katydids. They differ from the meadow-grasshoppers in the following ways: in the meadow-grasshoppers the tip of the head is sharply angled right where the feelers grow out, as shown in the figure; in the katydids it is rounded; in the meadow-grasshoppers the sword-like instrument with which the female lays her eggs (ovipositor) is slender, but slightly curved and often very long; in the katydids it is short, more like a Turk's scimiter.

Katydids live on trees and bushes, but some kinds on

595.7 CHICAGO PUBLIC LIBRARY
cop. 1

weeds and low plants. Trees standing by themselves in the desert are almost sure to harbor some. One of the best ways to find them is to go after them at night with a

Fig. 70—*The angular-winged katydid (Microcentrum rhombifolium). Below are its eggs around the edge of a leaf and on a stem*

Night hunting for katydids

spot-light. One can hear them singing, and sneak stealthily upon them, and when he locates the exact place from which their song is coming he can throw the spot-light on them, watch them sing, and catch them, for the light does not usually more than mildly disturb them.

The habits of katydids, except in the places they live are not very different from those of the meadow-grasshoppers. They do, however, lay their eggs differently, gluing them in double rows along a twig, or inserting them in a row around the edge of a leaf. A very few kinds lay them in holes in the ground. The eggs are large and look like flax seeds.

The music is made in the same manner as that of the meadow-grasshoppers, but they prefer to sing mostly by night, although many species have both a day song

Lie low

Celebrating in the wee small hours

and a night song. To sing much in the day time would advertise their whereabouts to their enemies the birds. Each kind has its own special song. By imitating it, one can make them respond. Scudder tells about doing this with one kind as follows: "It is more noisy by night than by day; and the song differs considerably at these two times. The day song is given only during sunshine, the other by night and in cloudy weather. I first noticed this while watching one of the little creatures beside me; as a cloud passed over the sun he suddenly changed his note to one with which I was already familiar, but without knowing to what insect it belonged. At the same time all the individuals around me, whose similar day song I had heard, began to respond with the night cry; the cloud passed away, and the original note was resumed on all sides. Judging that they preferred the night song to that of the day, from their increased stridulation during the former period, I imitated the night song during the sunshine, and obtained an immediate response in the same language."

Morse describes the habits of another species as follows: "Attention is chiefly directed to it by the loud stridulation of the males at nightfall. During the day they are usually silent, or at rare intervals produce a short sharp *zip*. After dark, however, they make the swamp resound with their loud calls, and we then become aware of their abundance. On close examination at such a time the males—usually only one on each bush —may be seen walking very slowly over the leaves and twigs. Occasionally they suddenly slightly lift and part the wing-covers and close them again, thereby producing a sharp *zip* or *crick*, this being their usual day note. After making this sound at intervals for some time, the wing-covers are opened to a greater extent, and are then again closed, producing a long-drawn, exceedingly loud

cr-r-r-r-r-ick, which is repeated in couplets several times in succession. This challenging cry is immediately answered by one after another of its neighboring fellows, until numbers are rasping out their ear-splitting notes, as notable a rural chorus as that of the tree-toads.'' *Full orchestra*

In our southwestern plains and deserts, some kinds are very slender, with exceedingly long spindling legs. The more usual kinds are stout and green and closely resemble leaves, which is one reason why they are often hard to find, and affords the best possible concealment for them from their enemies, the birds.

For methods of distinguishing bush-katydids from round-headed katydids, and each from meadow-grasshoppers and cone-headed grasshoppers, see paragraph 9, on page 183.

12 (*a*) *Squash-bugs.* (*Anasa tristis;* family Coreidae; order Hemiptera).

Squashes, pumpkins, melons, and cucumbers are the homes of rather large brownish bugs that have a highly disagreeable odor which has won for them in some regions the name of ''stink-bugs''; squash-bug is a better name for them, the name stink-bug being more correctly applied to another allied family.

Adult squash-bugs are a trifle over one-half an inch in length. They spend the winter under rubbish near our gardens. About the time that their food-plants get above the ground they come out and begin sucking the sap, puncturing the plant with their beaks, in order to get it. In exchange for the sap which

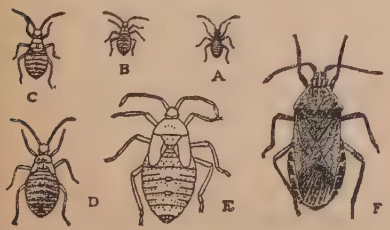


Fig. 71—*The growth-stages of a squash-bug, from (A) just hatched to (F) adult*

they take from the plant they inject a poison which may be sufficiently injurious to kill small plants.

The female lays her eggs in clusters of varying numbers under the surface of the leaves of the food-plants. The eggs are about one-seventeenth of an inch long and flattened on three sides. In from one to two weeks they hatch into gayly colored young squash-bugs which eat until they have to shed their skins in order to have room to eat more. Five stages are passed through before the winged adults become developed. Only one generation develops in a year and for this we should be duly thankful.

Squash-bugs live wherever their food-plants are grown, from Canada to Central America. For distinction between the squash-bug and the horned squash-bug, see paragraph I (a), on page 191.

12 (*b*) *Chinch-bugs.* (*Blissus leucopterus;* family Lygaeidae; order Hemiptera).

War

The war with insects is expensive, like all modern wars, crushing in its expense on both sides, and overwhelming to the poor farmer directly in the line of march. Chinch-bugs are said to have cost the people of the United States five hundred millions of dollars! Throughout the Mississippi Basin, and the Central States as well as in parts of the southeast it is a well-known and dreaded insect. Its range includes nearly the whole United States, but in the northeast and in the Rocky Mountain and Pacific Coast regions it is not so abundant as to be generally injurious and is consequently less well-known. The name chinch is also used in the south for bed-bugs.

The adult is about one-sixteenth of an inch long, blackish, with conspicuously white wings, and reddish legs. In the south the wings are of full length, covering the abdomen, but in the north many of the adults have wings

only about half the length of the abdomen, or even less, and these cannot be used for flight.

During the winter adult chinch-bugs can be found under the leaf-sheaths or husks of old dead cornstalks; also, but with more difficulty, among the roots of grass, and other such places. In the spring they migrate to new grain-fields, in the south often all together, filling the air like swarms of bees. They lay their eggs mostly between the leaf-sheaths and the stalks in winter wheat, but sometimes also in young corn and other grains or grasses. The young are bright red in color, but as they grow older they become duller or greyish. They insert their beaks in the tissue and suck the juices from the grain. They are very social in their nature, preferring to feed together in large flocks. The adults also do this. Growth takes about two months, and during this period, the harvesting of the grain leaves them without a food supply. They thereupon set out in a great army to migrate to the nearest corn-fields. They mass on the growing corn in such numbers as sometimes to conceal the stalks and bases of the leaves, and may destroy great corn-fields in a week's time.

Fig. 72—*Life-stages of the chinch-bug*

Armies on the march

12 (*c*) *The larvae of gall-wasps and their galls.* (Family Cynipidae; order Hymenoptera).

Every scout knows an oak-apple, and has also often seen many other curious swellings and knots on oak-trees and on their leaves and flowers. He has also noticed the mossy swellings on rose-bushes, or the prickly bunches on blackberry and raspberry-stems, and may have often wondered what all these things are. They are not natural plant-parts. They are called galls, and are made by gall-wasps. There are many kinds, mostly on oak-trees, but some on other plants. We can select only one, as illustrating their life-histories, although the details are very different with the different kinds.

Fig. 79—*An oak-apple cut open (Amphibolips confluentis)*

The oak hedge-hog gall.
(*Acraspis erinacei;* family Cynipidae; order Hymenoptera).

The leaves of white oak often bear on the underside a gall that has been likened to a little bunched up hedge-hog. It is of a dirty yellow and pink color, and covered all over with little prickles. Sometimes nearly every leaf on a tree will have from one to a dozen of these galls. In the fall the leaves drop, galls and all, the young insect inside of the gall. About the first week in November the adults emerge, gnawing their way out and leaving little round exit holes behind them. They are wingless, sluggish of motion, reddish-brown in color, and more closely resemble a lot of fat

Fig. 80 — *Oak hedge-hog gall*

Fig. 73 — *Wool-sower gall, Andricus seminator*

Fig. 74 — *White oak club-gall, Andricus clavula*

Fig. 75—*Oak knot - gall, Andricus punctatus*

Fig. 76—*Blackberry knot-gall, Diastrophus nebulosus*

Fig. 77—*Mossy rose-gall, Rhodites rosae*

Fig. 78 — *Spiny rose-gall, Rhodites bicolor*

Just climb up any old thing

torpid ants than anything else. They climb up any vertical object at hand, be it wall or what not, but those which crawl up any other object than the oak-trunk perish, while those that find the tree-trunk crawl out onto the twigs at the tips of the branches. All of these creatures are females, and without any fertilization from a male, they are prepared to lay eggs, which they insert into the winter buds of the twigs. In the spring these eggs hatch, and the irritation produced by the presence and secretions of the larvae causes the plant to form a growth around them, which finally becomes a tiny gall, about the size of a pin head, inside of the bud. The larva is a white maggot, legless and eyeless; it absorbs nourishment from the juices of the plants. It reaches its growth rapidly, becomes a pupa and is ready to issue as an adult when the buds burst and the leaves begin to expand. But what wonder is this! The adults that emerge are not at all like their mother. They are smaller in size, agile instead of sluggish, slender instead of corpulent, winged instead of wingless, and consist of both *males* and *females* instead of just females. Furthermore, they possess characters of structure that are so different from those of the mother, that until their life history was known, no specialist even would have suspected that they were close relatives of their own mother, and would have given them an entirely different name. These mate, and the females lay their eggs in the rapidly growing tissue of the young leaves, the eggs hatch, and these new larva in turn stimulate the plant to build a gall around them, but this time of totally different kind, in fact, the very hedge-hog gall that we started out with the previous year. And the adults which emerge in November will be replicas of their grandmothers, but have no resemblance to their mothers, and so it goes on in what naturalists call an alternation of generations.

Ladies only!

Fancy sparrows hatched from duck eggs!

The hedge-hog again

Like grandma like grandchild— leave ma and sonny out of it

Break open any sort of an oak-gall, and you will find one or more little hollow kernel-like cells in the center, surrounded by a smooth hard wall and in these you will find white grub-like larvae. These are the larvae of the gall-makers, but some of them may be the larvae of other kinds of gall-wasps, which do not trouble to build their own galls, but which live in the galls made by others. Or they may be the larvae of parasitic wasps, that will destroy the gall-maker larvae and feed on its tissues and juices.

Spongers and worse

12 (*d*) *Other galls.*

A great many galls on other plants, and a few on oaks, are caused by various sorts of insects other than gall-wasps, especially by gall-gnats (Family Cecidomyiidae). The larvae of the latter may usually be recognized by being of an orange color. A big bunch looking like a pine cone, but growing on a willow tree, is a common example of their work (pine-cone gall of the willow, *Rhabdophaga strobiloides;* family Cecidomyiidae; order Diptera), and they make galls on many herbaceous plants. A long swelling in golden rod stems is made by a caterpillar, and a very common gall is a marble-like swelling on wild lettuce made by a fly of the family Trypetidae.

Fig. 81 — *The pine-cone gall of the willow*

The observant scout, if interested, can learn many still unknown facts about the lives of these insects, and contribute in a very real way to the science of entomology, and perhaps really begin to earn a reputation as an entomologist.

CHAPTER III

KEEPING SOCIAL INSECTS UNDER OBSERVATION

REQUIREMENT NUMBER TWO

Make an artificial ants' nest, suitable for observation, and maintain a colony of ants for at least two weeks. Make a record of interesting facts and habits observed. Or do the same with an observation hive of bees.

DIRECTIONS FOR MAKING AN ANTS' NEST

List of Material Needed

(a) Plank about 10 ins. x 18 ins.

(b) 2 strips 10 ins. x 3 ins. x ¼ in.
2 strips 18½ ins. x 3 ins. x ¼ in.

(c) 2 strips 8½ ins. x 1 in. x ¼ in.
2 strips 18½ ins. x 1 in. x ¼ in.

(d) Some narrow strips about ¼ or 1/3 in. thick

(e) 2 pieces of glass each 4 ins. x 5 ins., preferably orange-colored

(f) 2 or 3 lbs. plaster of Paris or flour

The exact dimensions of the pieces of wood are not of importance. Take the strips lettered (b) and nail them on to the edges of the plank (a) so as to form a tray, with a wall about 2 inches high. Nail the strips lettered (c) flatwise on top of these so as to make a rim around the top (c), projecting ¾ of an inch toward the center. The space under this rim is to be kept banked up vertically with flour or dry plaster of paris, (f), or other harmless powder, so as to make a wall which the ants cannot climb.

Next take the narrow strips (d) and nail them onto the floor of the tray, in such a way as to construct in its center two adjoining compartments (g and h) each 4 x 5 inches (outside measurements), and ¼ or 1/3 of an inch deep. Connect these with each other and with the outside part of the tray by cutting narrow passage-ways (i) in the walls for the ants to go through. These compartments (g and h) are to serve as the ants' nesting

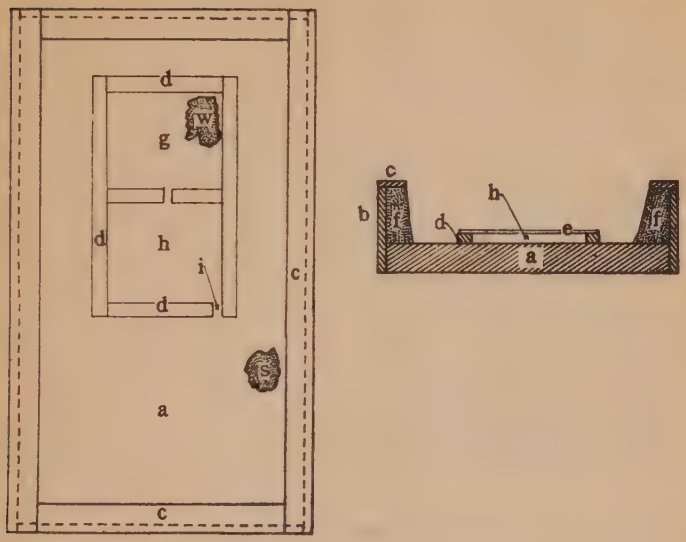


Fig. 82—*Top view and cross-section through center of ants' nest*

(*a*) *Plank forming base of nest*
(*b*) *Strips forming walls of nest*
(*c*) *Horizontal strip forming flange on top of walls*
(*d*) *Walls enclosing cells in which ants live*
(*e*) *Glass covering ants' cells; a separate pane over each cell*
(*f*) *Flour or other harmless powder banked up so steeply against the walls that the ants cannot climb out*
(*g*) *Darkened cell; keep glass top covered with a board when not under observation, or better, use orange glass*
(*h*) *Light cell.*
(*i*) *Ants' entrance-way to cells*
(*s*) *Sponge kept soaked with food for ants*
(*w*) *Sponge kept moistened with water*

places and should be kept covered with pieces of orange-colored glass (e). The ants do not perceive the light which comes through this glass and carry on undisturbed as though living in the darkness. If orange-colored glass cannot be obtained, use a piece of plain glass and cover it with a board when not under observation. In one of these cells keep always a well-moistened sponge (w) or piece of blotting paper, to keep the air sufficiently damp,

thus permitting the ants to select a moist place in (g) or a dry one in (h) as needed, in which to keep their eggs and larvae. Outside in the tray keep a piece of sponge (s) or blotting paper soaked with a thick mixture of raw yolk of egg, sugar and honey. Occasionally vary their diet with some chopped freshly killed insects. Miss Fielde says: "Sponge cake merged in honey or molasses, banana, apple, mashed walnut, and the muscular parts of insect larvae are among their favorite foods." The ants are free to run over the surface of the tray (a), but pile (f) of either dry plaster of paris or of flour or some other harmless powder must be kept heaped up against the edges of the tray all the way around so steep that the ants cannot climb up it. In this way they will be confined to the tray.

Stocking the Nest

Take a trowel and a pasteboard box and go in search of a colony of the kind of ant you may wish to study. Dig into it as deeply as may be necessary in order to uncover plenty of chambers filled with larvae, and pupae, and eggs; dig these out and transfer on the trowel as many of the immature stages as possible into the box, taking care not to injure them any more than can be helped, and of course put in many of the worker ants, more or less mixed up with the earth in which they are nesting. Best of all try to find the queen, which may be recognized by its much larger size. Take the box of ants back to the artificial nest that you have all ready, glasses and covers in position on top of the cells. Turn what you have brought out into a piece of cardboard, or the lid of the box, and set it within the artificial nest. After awhile the ants will find the entrance to the dark cells, and will carry in all of their brood; then the box lid and the earth on it may be removed. If there is too much earth brought in they may try to nest in it.

In order to clean either cell of the nest, one has but to cover it only with white glass for a while, until the ants, annoyed by the light, carry all of their young into the darkened chamber.

To open a large nest of the agricultural ant, one will need a shovel and pick, and will have trouble to avoid the stings of the ants, which are quite fiery. Carpenter-ants are to be gotten by crumbling the dead logs in which they live.

In order to live healthily, ants must have sufficient moisture, fresh air, and plenty of food. Do not let the sun shine directly onto the glass top of the cells, or it will kill the ants. When not under observation it is best to keep the glasses covered with pasteboard box-lids filled with earth, which will absorb the sun's heat if it should fall on them.

Other Ways of Making Nests

Another type of ant-nest, known as the Fielde ant-nest, may be preferred by some scouts. "It is made of panes of glass glued together by Le Page's liquid glue. A

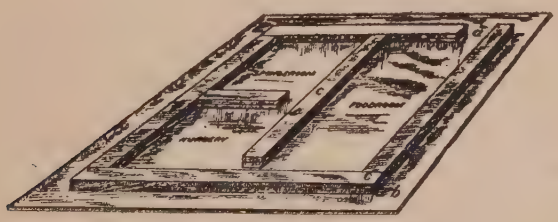


Fig. 83—*A Fielde ant-nest*

large square pane is used for the bottom. The wall and partitions are narrow strips of glass laid flat. Two strips of 'double thick' glass make it the right height. An aperture at (a) is left, but plugged up with cotton except when one wishes to transfer the ants to another

nest. On the top of each wall and partition is a narrow strip of coarse toweling. It is glued to the top of the glass and then the free edge turned back. The partitions and walls are then less than one-half inch high. Two panes of glass are used for the roof, so that one can be removed at a time. These roof panes are just laid on and not fastened. Over each is a piece of black blotting paper to darken the rooms. The outside walls are also painted black. In one room is a thin, flat piece of wet sponge; this is to furnish drink for the ants and moisture for the rooms. If the ants have many cocoons, a piece of dry cloth should replace the sponge, as ants keep their pupae in dry situations, while the larvae need moisture. The whole nest can be placed on a sheet of white blotting paper. Food is placed in one room. The other room is kept for the nursery. More elaborate nests can be made on this same plan, with more rooms and with some slender partitions near the larger walls to simulate ant runways. The roof may be fastened down and the nest carried about, or several nests may be fitted into a case especially made to carry them."

Still another, simpler, type of nest "is made by placing a glass jar or cylinder inside another glass jar of slightly greater diameter, the space between the two filled with soil, or wood dust, in which the ants can tunnel and form their nests. The inner jar is shorter than the outer, and the inner space or well is used as a food chamber. A stick leading from the bottom of the well to the top of the inner jar permits the ants to go from the nest to well and back. A net of wire should be placed over the top of the outer jar to prevent the escape of the ants; and a cylinder of black paper may be slipped over the outer jar to keep the galleries dark."

The Ants' Ways of Living

Here are some things suggested by Mrs. Comstock to do with your ants:

Put in some ants of another kind and see how they are treated. Put in some of the same kind from another nest. Later put in some from the same nest from which you took the original colony. Do the ants know the difference? Try putting in more larvae and pupae from this nest, and from others. How are they treated?

War

Welcome friend

What do the ants do with the dead ones? Do they have a regular place to put them? Do they ever change this place? Try putting in seeds, dry parts of insects, etc., and see how they take care of rubbish like that.

Cemetery

How do ants use their feelers? Watch them clean them. Do they ever seem to communicate with each other? How? Hide a wounded caterpillar somewhere on the tray, and see how soon they discover it. After the first ant finds it do the others come more quickly? Did the first seem in any way to spread the news?

Antennae, yes, but radio?

How do they treat the young? Do they gather them into piles according to size? Do they ever move these piles? What makes them move them? Do the eggs and larvae stick together? If so, why? How do they clean the young? Do they help the pupae to hatch? What color are the newly hatched workers (callows)? How do the other ants treat them? How long before they get their regular color? Do the other ants have to teach them what to do? Do you ever find one ant feeding another? How?

Nurseries

Flappers

Bring some branches covered with plant lice or mealy bugs and lay them on the tray. What do the ants do? The answer may depend upon the kind of ant.

Cattle

If your nest has a queen, how do the workers treat her? Does she take care of the eggs? Of the larvae? What becomes of an egg after it is laid?

Ma

Are there any big-headed workers (soldiers) in the nest? If so, what do they do?

The militia

Guests

There are many kinds of insects that live in the nests of ants as their guests and are wholly dependent upon them for a livelihood. Some of these the ants don't like, others they seem to welcome, and to feed. In digging into an ants' nest, if you are so fortunate as to catch any kind of an insect that is not an ant, be careful to keep it, and put it into the artificial nest and see what happens. Do the ants feed it? Does it have any way of asking food from the ants? Do the ants obtain anything in return from it? Some of these guests have little bunches of golden hairs at the base of which is exuded a sweet liquid of which the ants are exceedingly fond, and the ants lick these bunches of hair to get the sweet. Do the guests steal food from the ants? Do the ants try to catch and kill the guests? What about the young of the guests? Much remains unknown about these interesting creatures, and it will be worth while to carefully write up a record of all observations you make, and keep it, together with specimens of both the guest and kind of ant, in order that they can be positively identified, in case your observations should be found to bring out unknown facts. A good way to catch these guests is to place boards over the top of ants' nests, and from time to time turn them over, when the ants' guests may sometimes be found underneath. Curious little oval roaches are among the more common guests.

Of one of the guests, a chunky little red beetle, Dr Wheeler writes: "The beetle runs about the nest with surprising agility, or stands motionless, its front legs held up and turned forward." When a beetle in this position is touched by a passing ant, it begins to wave its front legs, as if to draw attention. The ant stops and begins to lick the beetle, or seizes it with her jaws. She carries it about the nest, or stops, and holding it upright

Pets

with her front legs, licks its head in a quick effusive manner. Suddenly it stops, sticks out its tongue and regurgitates a drop of food onto the beetle's face. Then the beetle sticks out its head, works its jaws, and rapidly consumes the food, which may have flooded its entire face. Then the ant licks the beetle's face, as though to clean it, and either leaves it, or regurgitates another drop. This feeding and cleaning alternates again and again, as though the ant were fascinated with her pet and could not feed and fondle it enough. The behavior of these ants, as they hold the chunky little red urchins in their paws and pour liquid into them as if they were so many casks, is a comical sight. Comical, too, is the behavior of the beetle while waiting to be noticed, with its head and front legs held up. At such times it assumes a ridiculous, cocky air."

Stop Thief!

Another kind of guest is a thief, and not welcomed by the ants. The French entomologist, Janet, tells about it: "From the instant the first foragers return to the nest chamber, these guests showed by their excitement that they perceive the odor of honey. Soon a considerable number of foraging ants are grouped in couples with those who have remained at home for the purpose of regurgigating food to them. They elevate their bodies, and often raise their front legs, leaving a space beneath. As soon as one of these guests come to such a couple, it slips into the space, raises its head, suddenly snaps up the droplet passing between the ants, and makes off at once as if to escape pursuit. But the ants, standing face

Fig. 84—*Ants feeding one another, while their guest, Lepismina, robs them of the drop of food*

to face, are not sufficiently free in their movements to even threaten the robber, which proceeds to take toll from couple after couple until its appetite is satisfied.'' This kind of guest has a body made slippery by a covering of smooth scales, and its body tapers to the tip, so that it is difficult for an ant to get a hold on it with its jaws. Figure 84 shows one of these creatures robbing two ants that are feeding each other.

Two good books

Every scout should read Dr. McCook's ''Ant Communities'' (See Bibliography, page 172, item 35), which is an interesting account of the habits of ants. More advanced scouts will be interested in several of the chapters of Dr. Wheeler's Ant-book, which tells, in a more technical way, very many astonishing things. (See Bibliography, page 172, item 36).

Before stocking your ants' nest, read what is said about ants under requirement number 1. 8. on pages 69 to 77 of the pamphlet.

THE CONSTRUCTION OF OBSERVATION-HIVES

Observation-hives, or small hives with glass sides, may be purchased from the larger manufacturers of bee-keepers' supplies, but these are quite expensive and no better than hives that may be constructed by scouts who have the use of simple tools and inexpensive materials. A carefully-drawn set of working plans have been prepared for this pamphlet by a scout. They are for a hive that will take a single frame of the standard Langstroth dimensions. Additional measurements will be given for a two-frame hive. By following carefully the plans furnished, you should be able to produce at small cost an excellent hive like the one illustrated here.

Utility of the One- and Two-frame Hives

For periods of one or two weeks, in May and June, the one-frame hive will prove very satisfactory, but by far the better instrument for prolonged use and ad-

Fig. 86.—*Side view of two-frame observation-hive. Hinged cover raised, showing screened ventilators and uncovering grooves on the ends of hive for receiving frames. One side taken off, exposing at bottom of hive the metal clips which hold the frames.*

End View of One-Frame Hive. Runway at Base

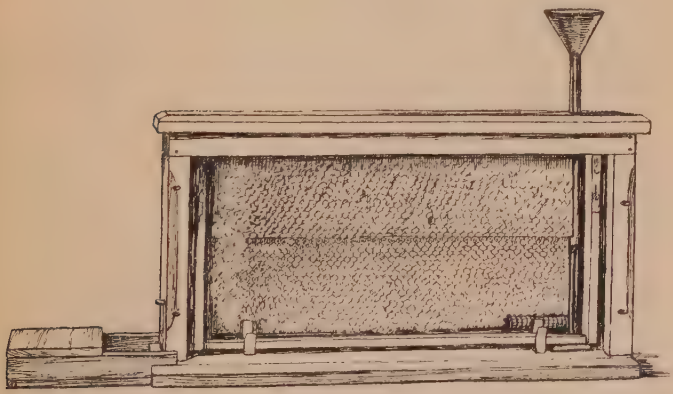


Fig. 87.—*Side view of hive with side removed and frame in place. Feeding funnel runs to a shallow pan at bottom of hive shown below the frames at the right. The cage on the right is for the queen. The covered runway on left fits under the window sash.*

vantageous operation is the hive constructed to contain two brood-frames. A larger number of bees can be kept and more normal interior conditions are provided, when the larger hive is used. One-frame hives are primarily for warm weather, whereas it is practicable to maintain and study the larger apparatus throughout the winter. One-frame hives have the advantage of exposing all of the inmates on both sides of the frame when opened, there being no place where the bees may conceal themselves. The two-frame apparatus on the other hand allows for protracted feeding experiments and permits the observation of phenomena that are all impossible in the smaller hive. These phenomena will be discussed elsewhere in this article.

Materials

One-frame Hive

1 bottom board 7/8 x 4 x 20 13/16 inches
1 top board 7/8 x 4 x 20 13/16 inches
2 end pieces 7/8 x 3 x 9 5/8 inches
2 strips 3/8 x 7/8 x 20 inches
2 shutters of 3/8-inch composition board 18 1/4 x 8 3/4 inches
2 heavy tin holders 1/2 x 1 7/8 inches
1 tin entrace closer 1 x 2 1/2 inches
4 2-inch squares of screen wire
2 1-inch hinges
6 small hooks and screw eyes
4 small screw knobs
2 pieces of glass 9 1/2 x 19 7/8 inches
1 frame with comb

Two-frame Hive

1 bottom board 7/8 x 5 3/4 x 20 13/16 inches
1 top board 7/8 x 5 3/4 x 20 13/16 inches
2 end pieces 7/8 x 4 1/4 x 9 5/8 inches
2 strips 3/8 x 7/8 x 20 inches
2 shutters of 3/8-inch composition board 18 1/4 x 8 3/4 inches
2 heavy tin holders 1/2 x 3 1/4 inches
1 tin entrance closer 1 x 2 1/2 inches
7 2-inch squares of screen wire
2 1-inch hinges
6 small hooks and screw eyes
4 small screw knobs
2 pieces of glass 9 1/2 x 18 7/8 inches
2 frames with comb
Clear pine lumber is the most desirable.

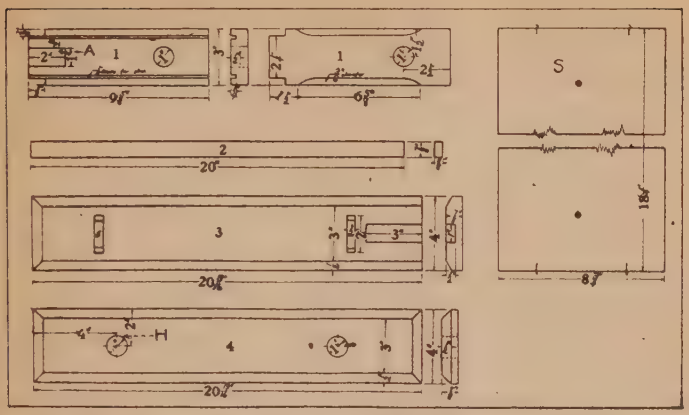


Fig. 85—*Construction of observation-hive. Drawing by Assistant Scoutmaster Donald T. Ries*

(1) *End*
(2) *Strip*
(3) *Bottom*
(4) *Top*
(5) *Metal holder for frame*

How to Build the Hives

It will be unnecessary to explain how to build more than one of these hives. For the sake of simplicity the construction of the one-frame is, therefore, given.

With a plane, bevel off the corners of one side of the bottom board (described in the list of materials) to the depth of one-half inch. At one end on this beveled side, draw the rectangle shown in number 3, figure 85. With a chisel, cut a trough in this rectangle which will be one-half inch deep at the edge of the board and taper up evenly to the level of the board and towards the center of the board. This will be the entrance to the hive.

Bevel the top board the same as you did the bottom board and in it bore two one-inch holes as shown in the figure. Tack a square of screen wire over each of these ventilator holes, on the unbeveled side. On one side of each end piece, cut two grooves, one-quarter inch deep,

two and one-quarter inches apart and equally distant from the edges. At one end, on the same side on which you have cut the grooves, chisel out a rectangular area two inches long, one and one-quarter inches wide, and one-half inch deep. (See figure 85, Number 1A). This last described groove will hold the upper part of the frame which bears the comb. Tack a square of screen-wire over each of these ventilator holes. In each end piece, bore a one-inch hole as shown in the figure. Seven-eighths inch from this same end, and from either side, saw in to the groove which will bear the glass. From the same end, saw along the outer edge of these grooves making the notch shown. If you saw in the groove instead of along the outer edge, you will be unable to put in the glass.

Nail the ends of the strips to each of the end pieces in the places just prepared for them. Nail or screw the end pieces to the baseboard. Fasten the top board to the top strips with the hinges. Bend the tin frame-supporters into a U, the base of which is one-half inch wide, and fasten to the bottom board as shown. With two tacks, make a guide for the entrance-closer. Fasten hooks and screw eyes and screw knobs as shown in the figure. Slip in the panes of glass and the frame is ready.

The Shedded Runway

Observation hives, whether operated in summer or winter, must be placed at a window so that the bees may have free exit on warm, pleasant days. A southern exposure is preferable in winter, while an eastern exit is better for the warmer months. It must be remembered, however, that a side exposed to the prevailing winds is always undesirable. A draughty observation-hive is certain to meet with disaster. The shedded runway is merely a tunnel of wood communicating with the outside, being attached to the front of the hive and projecting out under the sash. It permits the bees to come

and go without the annoyance of having any at large in the room. The runway for the two-frame hive is constructed of four parts of three-eighths inch material with the following dimensions:

Length (inches)	Width (inches)
5 5/16 of ⅜-inch material	Top 4
6 of ⅜-inch material	Bottom 5 5/16
7 of ½-inch material	Two sides ⅞

Stocking the Hive

A bee-keeper owning Italian bees and standard hives with movable Langstroth frames may be living nearby. If so, it will facilitate matters to arrange with him to obtain one frame of bees and a queen. Most bee-keepers will do this at a nominal charge, and, in addition, will, if required, look in from time to time to see that things are running smoothly. If bees are not procurable in the vicinity, a one-frame nucleus may always be purchased from dealers in standard Italian stock. A list of reliable dealers will be appended to this section. It is recommended that only Italian bees be purchased if possible. They are gentle, and give but little trouble to those who operate and care for the hive.

Operation

The shutters should always be on the hive when the bees are not under observation. The normal beehive is dark on the inside. The entrance should be kept closed when the wind is blowing directly into it; except in warm weather a draught will prove injurious to the bees if brood or young bees are in the comb. If a queen is not obtained for the observation hive, the little colony will soon dwindle away and die. A young queen lays very rapidly and will soon have all available space occupied with eggs, and in May or June a constant watch must be kept or the queen will lead out a little swarm and leave the hive without bees. An old queen that lays more slowly than a young one, is preferable for the

observation hive if one can be obtained. There are two ways to prevent a loss of the bees by swarming out. First, with a pair of fine scissors let the tip of the queen's wings be clipped. If possible, have an experienced bee-keeper perform this operation, if not, it may be carefully done by anyone without fear, for the queen does not sting when being handled. A clipped queen cannot fly. In attempting to lead out a swarm, she will fall to the ground and can easily be found if the grass is kept down under the window. She should be placed in a cage when this happens, and returned to the hive. The bees will come back. Second, from time to time it is advisable to cage the queen and keep her confined while the brood in the comb is developing. She should be placed in the cage on the bottom bar of the frame as shown in the cut. The worker bees will feed and tend to her during the period of confinement. The time to cage the queen is indicated by the condition of the comb, if all the cells are filled with eggs no further freedom should be given her until the emerging bees have made room for her to resume her activities. When it is necessary to manipulate the bees, the hive entrance should be closed and the apparatus carried outside. The manipulator should provide himself with a veil, gloves, and a small smoker. Handle the bees carefully and expeditiously. Return them at once to their stand. If the hive becomes overcrowded with bees, it should be closed up and removed at midday when many of the workers are in the field: a plain wooden box with an entrance hole can be set in its place, the returning bees will cluster in this receptacle and can be removed at night. The observation hive is then replaced, and the bees in the box may either be destroyed or united with other bees. If the feeding experiments, to be suggested later, are undertaken in a two-frame hive, only one frame of bees should be introduced when the hive is being

stocked. The second frame should be empty or purchased with a sheet of foundation only. Foundation is a sheet of wax upon which the bees build a comb, using it as a base. One gets a more regular comb than would otherwise result.

Feeding-apparatus for Two-frame Hive

Some interesting habits of the honeybee may be observed if a simple device is added to the equipment whereby the colony may be fed while being studied. The two-frame observation hive is to be recommended for this purpose. To it may be adjusted a contrivance that enables the operator to quickly perform several experiments in feeding, and which under favorable conditions permits the witnessing of the most remarkable phenomenon of the bee's world, the secretion of wax and the building of honeycomb. A glass, or tin tube, three-eighths of an inch in diameter, and approximately twelve inches long is inserted through a hole so bored in the hive-top that it permits the tube to pass down between the frames to the bottom, where it dips into a shallow receptacle. The lower end of the tube should be partly plugged so the feed will run but slowly into the pan. A small funnel is used to facilitate the pouring of the sirup. The sirup used for feeding the bees may be made by using cane-sugar, and hot water, in equal amounts; this should be stirred well until all the sugar is dissolved, and one-twentieth of a teaspoonful of tartaric acid should be added to each pound of sugar used. Bees require a high temperature in order to be able to secrete wax. When one frame in the hive has been left empty or supplied with comb foundation only, the bees will attempt to build comb in it, if feed is given regularly and as rapidly as they can take it up and if a high temperature is maintained in the room where they are kept. No more wonderful performance in the animal world can be witnessed than this building of honeycomb.

Studying the Bees in the Hive

During the months of May and June three kinds of bees may be present in the hive—the queen, the workers, and the drones. During the winter the drones will be absent.

The Queen

This long-bodied, graceful insect, the mother of all the bees in the colony, should be studied with care. Observe the position of her eyes, both compound and simple; the length, shape, and position of her antennae (feelers); length of her wings as compared with the great extent of her body; and lastly the length, color, and pointed tip of her abdomen. The queen has a sting that she rarely, if ever, uses on man. It is reserved for combative encounters with other queens. There is only one queen in any normal colony of bees.

The Worker

Next in importance to the queen are the workers. Compare the size and color of the body, the shape of the compound eyes, and the length of the antennae, with that of the corresponding organs of the queen. Note the difference in color in individual workers. Very old field-bees may be nearly black; their delicate wings are usually frayed also. The young bees are light in color. Can you discover to what their difference in color is due? The workers do all the work, gather nectar, pollen, and bee-glue, keep the hive clean, build the comb, nurse the young bees and take care of the queen. The workers are the bees that sting. If you look carefully some day, you may observe the sting of the worker bee protruding.

The Drone

This large burly fellow will appear in the spring, but you will not find him during the winter, because his sisters, the workers, pitch him out of the hive in autumn. Study carefully the drones when they come. Note how very different they are from the queen and the workers.

Observe the enormous compound eyes that meet on the top of the drone's head. The position of his simple eyes may be noted also. Notice his extremely long wings, and the rounded tip of his abdomen fringed with bristly hairs. The drones do not gather honey or do any of the work in the hive. They are perfectly harmless for they are not provided with stings.

Egg-Laying of the Queen, and Brood-Rearing

If the observation hive is established in the autumn, there will follow a period in which no eggs will be laid by the queen. If no mishap occurs to the colony during the winter, egg-laying will begin early in the year and the queen's method of depositing her eggs, one in each waxen cell, may be observed. The eggs are nearly one-sixteenth of an inch in length and may be plainly seen. The brood-comb will probably contain cells of two sizes. Drone-cells are one-quarter of an inch in diameter and workers' cells, about one-fifth of an inch across. When the eggs hatch (note number of days), small wormlike baby bees, called larvae, may be seen in the cells. At this time the activities of the nurse-bees feeding the larvae should be studied. Note the color and changes that take place in the development of the larvae from day to day. At the time brood-rearing begins, two things necessary for the nourishment of the immature bees must be supplied—water and a substitute for pollen, an indispensable food. Water may be introduced through the feeding apparatus, and fine rye flour mixed with a little lycopodium powder (procurable at pharmacies) can be placed in a shallow dish and pushed into the shedded runway. This makes a fairly good substitute for natural pollen. After a period, the cells will be capped over and the larvae then change to pupae. Observe the difference between the capping-over of the worker- and of the drone-cells.

Bringing in the Pollen

When pollen is being brought into the hive, the wonderful little baskets on the hind pair of legs of the worker-bees should be studied; also how they deposit the pollen and pack it in the cells. Masses of pollen mixed with honey when packed in the comb are called bee-bread. Do the bees cap over the cells containing pollen? In the spring you may observe shining brown beads in their pollen-baskets. They are tiny lumps of bee-glue that the bees gather from the sticky buds of certain plants.

Emerging of the Adult

After twenty-one days from the time the eggs were laid, the cappings of the worker-cells will be gnawed through, for bees have strong jaws, and the full-grown bees will begin to emerge. The drones will require twenty-five days to complete their development. The conduct, appearance, and reception of these young bees should be studied.

Collecting Sweets, and Feeding Habits

Pour a little sirup into a top ventilation hole and tilt the hive until some of it runs down one of the glass sides. Many bees will hasten to gather this sirup from the glass and the long, flexible, highly-developed tongue may be closely studied. It is like a tube and the sirup is sucked through it into the honey-stomach by the worker-bees. It is then carried to a cell and regurgitated. By coloring the sirup with some harmless candy coloring matter, red, yellow, or green, the exact spot where it is being deposited may be observed. If two colors are fed simultaneously it will be interesting to see if the bees keep the colors separate or whether they mix them in one cell. The tongue is used in feeding the queen and the drones. Try to detect the honeybees in the act of using their tongues in this manner.

Cleanliness of Bees

Much of the bees' time is taken up in keeping themselves and their home immaculately clean. Many individuals spend much time in keeping their newly-emerged sisters tidy. The tongue and anterior pair of legs are mostly used in these operations. Debris and dead companions are removed from the hive whenever possible. Flour may be puffed through the top ventilators of the hive, covering several individuals; note the way that they have of ridding themselves of it. Observe antenna-cleaner on the front legs of the workers; its employment is very skillful and amusing. Place a rather large piece of raw meat on the bottom of the hive; if it is too large to remove the bees will cover it with bee-glue. This experiment should be attempted only in the spring when bee-glue is obtainable by the bees.

Fanning

In the midst of many bees actively moving about, one will now and then be seen standing still, vibrating its wings at great speed. Such bees are fanners. They set up currents of air and keep them circulating in the hive. The song of the bee is the humming caused by the rapid beating of its gauzy wings. This song can be distinctly heard when the fanners are at work. Bees are capable of making several notes, one when angry, and one when happy and contented. Still another is heard when they have lost their queen. The drone makes a song with his wings that is very loud and blustering.

Response of the Workers to the Presence of the Queen

The extraordinary sight of a ring of workers around the queen, their heads all turned respectfully toward her, may often be witnessed in the observation hive. It is thought that her odor is responsible for this behavior. It should be observed that wherever she moves on the comb, room is made for her, and when she pauses a number of workers seem to pay her homage.

Other Things

When the shutters of the hive are removed and the interior is suddenly flooded with light some of the bees will act in a peculiar manner.

The bottom of bees' feet are provided with sticky pads, called empodia, and the bees are enabled to run over the smooth surface of the glass because of these organs. After a time, the glass sides of the hive will become clouded and will require washing. A substance coming from the empodia is responsible for this.

It may be interesting to note the response on the part of the bees to foods other than those normal to them. Sirup or diluted honey may be mixed with harmless substances ordinarily foreign to the experience of bees, and fed in small amounts. Their reaction to such food will afford interesting material for observation. Essential oils, such as wintergreen, or the acid juice of lemon may be used and the sirup may be fed hot or cold to vary the experiment.

CHAPTER IV

MAKING A COLLECTION OF INSECTS

REQUIREMENT NUMBER THREE

Make a collection of 50 species of insects. This collection will be judged upon four points: (1) *correctness of names*; (2) *neatness of arrangement*; (3) *perfect condition of the specimens (clean, unbroken, and properly mounted)*: (4) *adherence to the following rules*:

(*a*) *It is desirable that each species be represented by two male and two female specimens when they can be readily found and the sexes easily distinguished.*

Each kind of insect is incompletely shown without specimens of each sex. Often the sexes can be easily distinguished by color (as in many butterflies and moths) or by shape of antennae, or number of segments in the antennae (thirteen segments in male and twelve in female bees and wasps, also any bee or wasp with a sting is a female or worker), or by shape or structure of the abdomen, but no rule can be laid down for all, and often it is very difficult to distinguish them. The scout need only distinguish those for which he can find an easy method.

Why two?

The scout may wonder why one specimen of each sex is not enough. There are several reasons why it is better to aim to have two, but if the insect is rare or difficult to obtain, it is all right to be satisfied with one. Insect-collectors, if they are making their own private collection, usually adopt a definite number, such as four, or eight or twelve of a kind which they call a "set," and in arranging their boxes they leave room for that many of each species, and try to obtain them. Additional specimens they store away as "duplicates" for exchange with other collectors.

The bug's own set

You and I are different

One reason why the "set" consists of several specimens is that many insects of the same kind are different from one another in details of color, size or even form; that is, as we say, they show individual variation. For example, of the six-spotted tiger-beetle, very common in the east, some individuals are bright green, some decidedly blue, some have six yellow spots on the wing covers, some less, some none. By putting in the "set" such different individuals, one shows at once to any one interested in this species that he need not expect to find all specimens alike, and shows him just about what differences he will find, and furthermore makes clear, that if one chances upon one of these different individuals that it really *is* a six-spotted tiger-beetle, and not something else to puzzle over. On the other hand, if the specimens of the "set" are all alike, one may assume that that particular insect doesn't show much variation in the region where the collection was made. Entomologists, however, like to have the specimens in their "set" come from as many different regions as possible, so as to give some idea of extent or geographical distribution of the kind.

Where do you live, Mr. Bug?

Fancy dress

If you watch a parade, two or three ranks of men going by in a particular fancy uniform of some organization make quite an impression, don't they? But if the parade were to consist of just *one* man from each organization wearing its uniform, and walking in file down the middle of the street, it wouldn't amount to much, would it? Do you get the idea? A *group* all alike, makes an impression that *one* individual does not. Carry the idea to the insect collection; a little block of individuals all of one kind neatly arranged in one or two ranks, just like a parade, carries an *impression,* and helps us remember that species, by calling up in our mind the mass-image that they have created.

Parade of the Bugs

Scouts like to do things right, and not by simplified "kid's" methods, so we have drawn up these rules to produce a collection that would meet the critical approval of a technical entomologist; and we feel confident that scouts will take pride in producing such.

Snap into it!

(*b*) *A neat written or typewritten label stating the name of the species (either common name or scientific, or both) to be pinned on the left of or above the row of specimens of each species.**

It is easy to tell that you are a scout, and your rank, by looking at your uniform, but to tell *what kind* of a scout you are—that would be more difficult until I know you pretty well, wouldn't it? It is an easy matter to tell the kind, in general, that an insect belongs to, as bumble-bee, or water-strider, or crane-fly, but to tell the *exact kind* (species) is a different matter. In New York State there are found thirteen different kinds of bumble-bees, of two genera, nine kinds of water-striders, of five genera, but about three hundred kinds of crane-flies, of some fifty-three different genera, for crane-flies form of themselves a whole family of flies. To tell the exact species of an insect is often a technical matter requiring the knowledge of a specialist. How far and how successfully the scout can go in determining his specimens will depend upon the books to which he has access and his skill in using them, upon collections in museums which he can visit, or upon the help of those who know. All that can be asked of a scout is that he distinguish the kinds and find their names as closely as he can, with the means at his disposal. What for one scout would be easy, for another would be impossible.

Who are you, please?

Tough job

But the scout should remember that only fifty kinds are asked for, and nearly every scout can find that

* For method of arrangement of specimen-labels in boxes see page 149.

Not so bad, though

many, of which he can find the exact kind, even though he find many more of which he cannot. In fulfilling requirement number one, he will have become acquainted with and should have collected and can use for his collection specimens of the following: Solitary bee or wasp; carpenter-ant or agricultural-ant, tiger-beetles (several kinds); back-swimmers; whirligig-beetles; carrion-beetles (two or three kinds), or tumble-bugs; squash-bug or chinch-bug; meadow-grasshoppers or katydids; leaf-beetles (several kinds); crane-flies or robber-flies or both; damsel-flies; water-striders; and several kinds of bumble-bees. This will be a good beginning toward a collection. Of some of them he will have found the name of the particular species, of others he will not be able to do that.

On pages 175 to 198, of this pamphlet, will be found hints for naming a number of kinds of common insects.

If there is a natural history museum, or an agricultural college in the community do not fail to visit it; from the collections displayed you will obtain the names of many kinds more easily and more certainly than in any other manner. Do not hesitate to ask the officers in charge of the insect department to help you get the names of any that puzzle you. Instead of feeling bothered, they will certainly be glad to help you, and pleased to find that you are interested. So likewise ask the help of any man in your town who is known as a naturalist, or insect collector. You may make some friendships this way that will be well worth while.

Finally, in any library you will almost certainly find some books on entomology, which will help you. The most useful books for determining kinds of insects are listed at the end of this volume.

Every state has an Agricultural Experiment Station, many of which issue bulletins about the insects, espe-

cially the injurious ones, of their states. These can be obtained free upon request, and will serve to identify some kinds. The farmers' bulletins issued by the United States Department of Agriculture, on different insects are also free, and useful in the same way. One can get lists of them, and choose those that he wants.

(c) *The species of each family and order to be arranged together, the sequence of orders and families to be that followed in a text-book, the scientific name of each to be indicated by appropriate labels.*

This is a natural order of arrangement, because the purpose of scientific classification is to bring naturally related kinds together, and these next to their nearest kin, and so on in an orderly sequence.

One can obtain the name of the family to which any insect belongs from the source where he found the name of the insect, or from a text-book. The order of arrangement of families and of orders is to be that given in the list of families appended to this pamphlet, see pages 199 to 214. Unfortunately books do not always agree as to the name used for a family, which causes one to be puzzled at times.

(d) *Insect-pins to be used, when obtainable, instead of common pins.*

Insect-collectors mount their specimens on specially made long, slender pins, and if you ever wish to exchange specimens with other collectors, such pins must be used. They are much better than the short, thick common pins, because they are high enough to carry data labels beneath, to remove the insect from contact with the bottom of the box, which would increase the danger to it, and to leave plenty of room for handling at the top, without danger of breaking the specimen; also because they are thin enough not to damage small insects (they come in assorted thicknesses); and finally because they look much neater.

Pins

Unfortunately since the war there has been much difficulty in obtaining these pins, and high prices are often charged. Many entomologists are finding it more satisfactory and much cheaper to send abroad for them. Addresses of dealers, both in this country and abroad, are given on page 152.

Avoid the soft brass pins, which curl and bend very easily. The best pins are made of steel and are japanned; what are known as "Ideal Stahlnadeln" are sold by the foreign dealers listed and are very satisfactory.

HOW TO MAKE AN INSECT COLLECTION

Where to Find Insects

Each kind of insect lives in a particular kind of place. To find all kinds of insects look in all kinds of places. Most "rare" insects are rare because one does not know the right place to look for them, where they may really be common. Use your scout-brains in thinking up different places to hunt. Here are a few suggestions.

Flowers: Flies of many kinds, beetles, wasps, bees, ichneumon-wasps, saw-flies, some bugs, butterflies. Many kinds of bees visit only their own special favorite kind of flowers.

Leaves and stems: Caterpillars, leaf-beetles, saw-flies, lady-beetles, bugs, grasshoppers, walking-sticks, mantids; ants tending aphids; scale-insects, plant-lice.

Under loose bark: Many beetles, beetle-larvae,* some bugs, roaches, and ants; scorpions, centipedes, spiders.

On dead animals: Carrion-beetles, their larvae, fly-maggots; rove-beetles; dermestids.

* Larva is the young (caterpillar or grub stage) of many insects. It is the eating and growing stage of the insect. Pupa is the between stage (chrysalis). It is the time when the insect lies quietly and does nothing but rest, while the wings are being grown.

In fungus: Fungus-beetles, rove-beetles.

In cow manure: Dung-beetles, rove-beetles, fly-maggots, tumble-bugs.

Under stones: Ant-colonies, ground-beetles, rove-beetles, crickets, roaches, some bugs; pinacate-beetles; potato-bugs (California); scorpions, centipedes, spiders, bristle-tails, spring-tails, earwigs.

On margins of streams: Shore-bugs, toad-bugs, ground-beetles, many kinds of flies, rove-beetles, marsh-treaders, spider-hunting wasps; grouse-locusts.

On surface of water: Whirligig-beetles, water-striders.

Swimming in water: Water-scavenger beetles, water-tigers, predacious diving-beetles, water-boatmen, back-swimmers, young of dragon-flies and may-flies.

On bottom, or under stones or in mud under water: Water-pennies, black-fly larvae, young of dragon-flies, damsel-flies, may-flies, and stone-flies, caddis-worms, hellgramites.

On sandy places: Nesting sand-wasps and bees, velvet-ants, robber-flies, tachina-flies, tiger-beetles, certain grasshoppers.

Along roads and paths: Thread-waisted wasps, tiger-beetles, grasshoppers, butterflies.

In damp and rank vegetation of marshy places and shady damp woodlands: Very many kinds of parasitic wasps, many kinds of flies, some beetles and bugs; meadow-grasshoppers; crane-flies, scorpion-flies, moths.

In open fields: Grasshoppers, butterflies, beetles, bugs, crambid moths.

At night at lights: Moths, beetles, water-bugs, assassin bugs, ophions, leaf-hoppers and plant-bugs, caddis-flies, may-flies, dobson-flies.

In hollow twigs: Wasps' and bees' nests; ants' nests.

In clay banks: Bees' nests and the bees.

Late Fall, Winter, and Early Spring Collecting

While much of the work and observation necessary to obtain the insect-life merit badge can only be done during the later spring and summer months, when insect-life is at its height, still even in regions which have a cold winter, much can be done at other seasons.

Of the insects coming under requirement number one, the following may be mentioned as obtainable during this season: Bees nest in stems and twigs or dead wood, and these nests often contain living adults, as well as young which may be kept (in the nest) in a box and bred out in the spring. Colonies of carpenter-ants may be found in the heart of dead logs, and other ants may be found in hollow twigs or under stones. Potato-beetles hibernate (i.e., winter over) under rubbish and in the soil -lock around potato-patches for them. Grouse locusts spend the winter under rubbish, bark, or other hiding places, and often come out on sunny days in winter. Queen bumble-bees winter-over in holes in banks, sometimes in rubbish or moss, and may best be found in the fall. Back-swimmers spend the winter in mud at the bottom of pools, or in open pools, or even under ice. Whirligig-beetles may be found during the winter, and also may-fly nymphs and sometimes mosquito larvae.

There are some true winter insects, such as the stone-flies of the genus Capnia, which one sees crawling about over fences and walls in late winter in the north, while snow is still on the ground. They are slender black winged insects, easily recognizable.

Mr. E. A. Schwarz (see bibliography, item No. 50, pages 76 to 85) gives very valuable directions for fall, winter and spring collecting of beetles, which we quote in part:

"There are more kinds of beetles," he says, "over-wintering as adults than of other kinds of insects. Great

swampy tracts, inaccessible in summer, harbor an abundance of rare beetles, difficult to find in summer, but which leave the swamp in the fall, and hibernate on drier ground around its edge, under old leaves, bark of trees, or in rotten logs. In late fall, warm spells in winter, or early spring such places yield a rich return Beetles can best be found when the ground is fairly free from frost. Good collecting places are accumulations of leaves along the edges of woods, under shrubbery along streams, in thick moss, under loose bark of dead trees and logs. In early spring beetles begin, on warm days, to 'swarm,' flying about through the air in great numbers, especially toward evening."

Catching Insects

Many can be best caught by hand. Only bees, scorpions, wasps and a very few caterpillars sting and none (except perhaps a few spiders) bite enough to hurt. Darning-needles, walking-sticks, earwigs, rear-horses, etc., are all perfectly harmless.

Flying insects must be caught in a net. Use a net quickly as though you were catching a ball thrown at you. Then with a quick turn of the wrist, imprison the insect so it cannot fly out. Sometimes a forcible stroke of the net may be used to drive the specimen to the bottom of the net. Don't open the net and look in to see what you have or the insect will fly out very quickly. Keep it closed and look through the net. If it is a wasp or specimen you do not wish to touch, with the left hand gather the side of the net around it, from the outside, imprisoning it in a little pocket. Then slip the cyanide bottle with the right hand up through the mouth of the net to the spot where the insect is, and knock the specimen into the bottle. Quickly slip the cork into place and the dreadful deed is done. There is no need to get stung in catching a wasp or hornet. A large wasp or

Strike!

Stung!

bee can sting through the net, and one's finger must not come into contact with his business end, even with the net between, but out of many thousand wasps and bees which the writer has caught, he can only recall one or two instances where he was stung.

Hot dawg!

Sometimes you look in the bottle to see what you have caught and find (if you know enough to know it) a *very rare* insect. Then aren't you the lucky scout! But most insects are common. That's why they are common, because they are most insects.

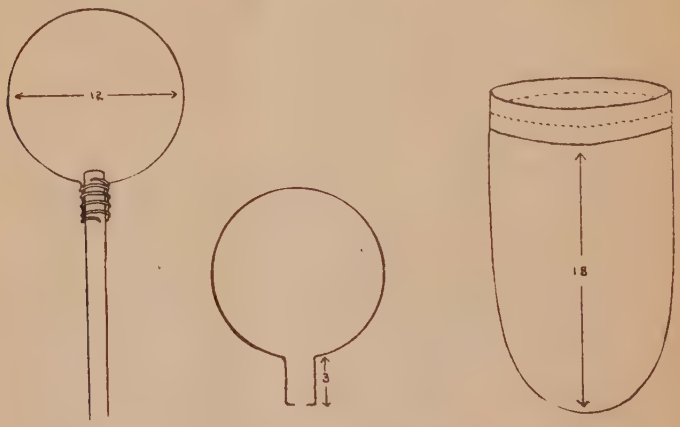


Fig. 89—*The net-hoop, the net-handle, and the net-bag*

Net

Hoop

You can buy a net or make one. Make a loop of No. 9 coppered iron wire 12 inches in diameter, turning out the ends for 3 inches, as shown in figure 89, and turning in and sharpening the extreme ends. Make a 3-inch groove on 2 sides of the handle at one end, to hold these turned ends, drive in the points and wrap soft copper wire all around to hold tightly in place, as shown in figure 89.

Handle

The handle should be light and strong, not over $\frac{5}{8}$ inch diameter. A broomstick is too heavy. A broken golf stick makes a wonderful handle. Hickory is of

course the best wood, but not essential. The handle should be 31 inches long.

Cheese-cloth is cheap and strong, but hard to see through; if it is used, buy a cheap grade, with as large a mesh as can be found. Bobbinet makes a much nicer net, but tears easily and a net is given hard usage. Silk bolting-cloth is the very best, very strong, easily seen through, one net lasts a long time; but it is very expensive;* ½ yard makes a net; get the grade numbered 00. Take a piece of cloth 1 yard wide and ½ yard long, cut and sew into a bag the shape of figure 89, rounding the bag so that there is no point at the bottom; sew it onto a band of heavy unbleached muslin or duck, 3 inches wide and as long as the circumference of the net ring, (about 1 yard). Turn the top of the duck strip back over the net-hoop 0, for 1 inch and sew around, which will make a duck guard-piece 2 inches wide at the top of the net around the hoop.

Bag

How to Kill Insects

First method: *Cyanide-bottle.* POISON.

Take a wide-mouth bottle or jar (vaseline-bootle, olive-jar, pickle-jar, candy-jar) that can be closed with a long cork or screw cap. Place in the bottom a little cyanide of potassium (deadly poison, use *great care*) say one-eighth ounce; cover it with sawdust, and the sawdust with a piece of blotter cut to fit. Make a mixture of one part plaster of paris to one part of water, and quickly pour it in on top of the blotter, making a smooth, even floor of plaster of paris all over the bottom of the jar, which must be allowed to set a few hours until hard. Two or

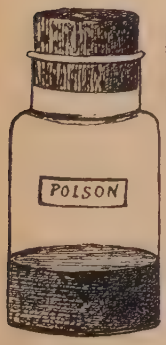


Fig. 90 — *Killing-bottle*

* About $2.60 per yard if obtained from a dealer in flour-mill machinery, very much more at a dry-goods store.

three bottles of different sizes will be handy and especially a small one for little insects.

The cyanide makes gas that comes through the plaster of paris and quickly kills any insect placed in the jar. Always keep the jar clean and free from dampness, which would spoil the insects. Wipe it out with tissue-paper. When in use tear up strips of soft tissue-paper and put plenty into the jar; this keeps the specimens from injuring and wetting each other.

Clean and dry!

A cyanide-jar should last all summer. Often a few hours' exposure to cyanide fumes turns yellow wasps red.

Second method: Carbon tetrachloride. Not Poison.

Wet some cotton with carbon tetrachloride (ether can be used, but doesn't last so well) drop it into the bottom of the bottle, cover it with dry cotton and plenty of paper. The gas will quickly kill insects. Keep plenty of tissue-paper strips in the bottle to prevent the insects from getting wet. The insects must be left in two or three hours or they may revive again.

Third method: Denatured alcohol.

This method, simply dropping specimens into alcohol, should be used for all soft-bodied insects (caterpillars, spiders, larvae, pupae), and is also good for beetles and ants, but not for hairy or winged insects. To the alcohol add about one-sixth to one-fifth the quantity of water.

Preserving Insects

Soft-bodied insects are left in alcohol.* All others are pinned, allowed to dry and need no special preservative.

* Soft bodied insects may be dried and pinned and will keep perfectly after the following rather complicated special method of preparation: Kill specimens in denatured alcohol mixed with three-fifths its volume of water. After at least two hours change them to strong denatured alcohol, for at least two hours, then to a jar of denatured alcohol half filled with quick lime, which can be used repeatedly until the lime is slaked. After at least two hours, transfer them to pure xylene for a few hours, then take out pin and dry.

Mounting Insects

Do *not* use common pins (no, not even for common bugs). Use insect pins. Use No. 3 pins for large and medium sized insects. No. 1 or No. 0 pins for small insects. Mount tiny specimens on paper points (see below). For further information about pins, see page 133. *Pins*

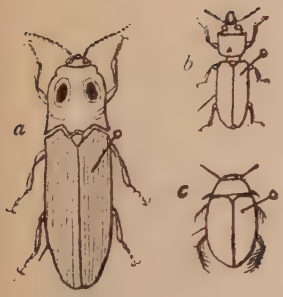


Fig. 91—*Where beetles should be pinned*

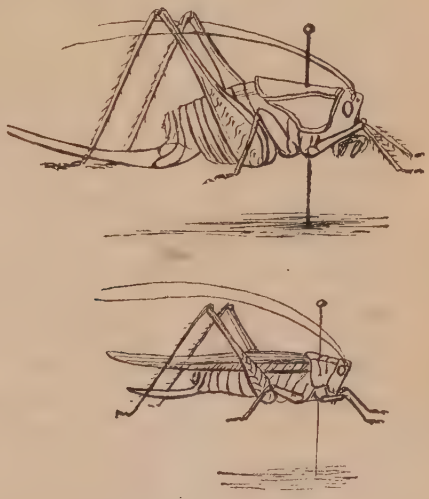


Fig. 92—*Where other insects should be pinned*

Pin a beetle through its right wing-cover, one-quarter way from its base to its tip. Pin other insects through the thorax midway, between the bases of the wings. *Beetles*

Turn the specimen upside down and run the head of the pin through the hole in the bottom step of a step-block, until it comes to the bottom of the block. Run the insect down the pin until its back touches the step. This secures even spacing of all specimens on the pins. *Others*

A step-block is shown in Figure 93. A simpler one will answer better that has two steps instead of three

Fig. 93—*A step-block*

Take two strips of wood, one-half inch thick and about one-half inch wide, one two inches, the other one inch long. Nail the short one on top of the long one at one end of the latter. Drill a hole a little greater in diameter than an insect pin all the way through each step. The bottom step can be used to bring the back of each insect one-half inch from the head of the pin, and to bring a locality label one-half inch from the point. The top step is to bring a triangular coardboard point one inch from the point of the pin.

Points

Cardboard or celluloid points, one-quarter inch long and one-sixteenth inch wide may be bought or cut. They are used for tiny insects.

Fig. 94—*Differently shaped points*

Putting on points

Run a pin through the broad end of a point, and down through the hole in the top step of the step-block, bringing the point to the level of the step. Take it out and touch a little glue to the tip of the point (don't daub on a pint or two) and touch it to the underside of the thorax of the specimen, pressing it firmly down, in such a position that when the sharp end of the triangle points to the left, the head of the insect is directed *away* from you (See figure).

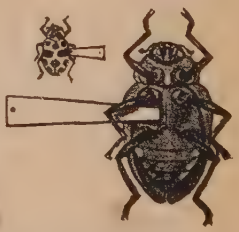


Fig. 96 — *Method of gluing an insect on a point, enlarged. (Top the same, right side up and natural size)*

The wings of moths, butterflies, dragon-flies, and the right hand wings of grasshoppers should be spread on setting-boards. This requires a little skill. The groove should be of the right width to fit the body of

Fig. 97—*A spreading-board of the inverted type*

the insect. The pin head fits into one of the holes in the groove, bringing the back of insect against the groove. Cut a long narrow strip of paper (a) and fasten with a mourning pin at (b). Insert another pin at (c) to keep the body from turning. Use the point of a mourning pin behind a strong vein of the front wing at (d) to move the wing forward over the board until its hind margin is at a *right angle* to the body. Insert a pin at (e) to hold it. Now move up the back wing to the position shown, stretch strip of paper (a) tight and insert pin at (f) to hold the back wing in place. Then cover the exposed part of both wings with a piece of cardboard, pinning it down. Treat the left hand wings in the same way. Arrange the feelers and legs uniformly, and let dry for a couple of weeks.

Spreading

The method just described for the "inverted" spreading-board is the easiest way to make a spreading-board, and it works very well. Most insect-collectors, however, use a different method, and if the scout has many specimens to spread, he may find the following more satisfactory:

Upside down

The materials needed for a medium-sized spreading-board are: two strips of pine or of some other very

soft wood, eighteen inches long, one and one-half inches wide, and one-half inch thick; one strip of wood, eighteen inches long, three and one-quarter inches wide, and one-half inch thick; two cleats, three and one-quarter inches wide, three-quarters inch high, and one-half inch thick; and two cleats, one inch wide and as high and as thick as the others; and a strip of cork or linoleum, seventeen inches long and a little less than one inch wide.

To construct the spreading-board, place the narrow strips of wood one-quarter inch apart, and on the under side fasten them across the ends to the longer cleats. Then, on the same side as the cleats, tack the piece of cork or linoleum over the space between the strips of board; and as the cleats are one-half inch wide, the linoleum should cover all the space left. Midway of the length of the boards fasten the two smaller cleats. Figure 98 shows a cross section of the spreading-board, just in front of these two middle cleats. Now it is ready for the bottom board, which will fit exactly if these directions have been correctly followed, and this completes the spreading-board. The space between the two upper boards is wide enough to take in the body of the moth or butterfly. The cork or linoleum below the space will hold firmly the pin on which the butterfly is impaled. The cleats hold the top and bottom boards apart, and so protect the points of the pins. Spreading-boards may be made much smaller or much larger, to suit moths of different sizes; but the space between the top boards must always be large enough to admit the body of the insect.

Right side up

Fig. 98—*A Spreading-board*

To use the spreading-board, insert the pin with the butterfly on it into the linoleum just far enough so that the body of the insect will be in the space between the boards up to the wings (figure 99). Place the wings out flat on the board, and fasten them there by pinning narrow strips of paper across them (figure 98). While they are held down by these strips of paper, arrange them so that the hind margins of the front wings will cover the front margins of the hind wings, and will be in a line at right angles to the body; then pin larger pieces of paper over the rest of the wings (figure 98).

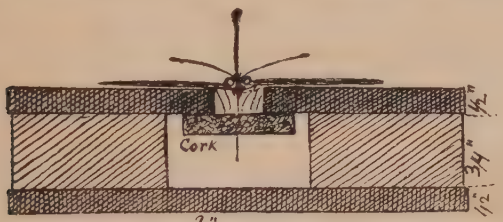


Fig. 99—*A cross-section of the spreading-board in front of the cleat*

Sometimes mica is used instead of paper to hold the wings down (figure 98). The insects should be left on the spreading-board at least three days; and when the board has insects on it, it should be kept in a box where museum-pests and mice cannot get at it.

Fresh Insects must be pinned or spread while fresh, before they have become dry and brittle, or they will break. Usually they dry enough to break in twenty-four hours, or in hot weather more quickly. They can be kept longer by putting them in a tight tin box which does not allow evaporation of the moisture. If they are to be kept soft more than two days, a bit of blotting paper moistened with a drop of carbolic acid must be put in the box to prevent mould.

If the insects have become dry and brittle before pinning, they can be softened by placing them for one or

Softening

two days in a tight tin box or glass jar containing damp blotting paper, cloths, or sand. A drop or two of carbolic acid prevents mould. Don't let the specimens become wet, only dampened.

Pin-Labels

The label

Every specimen must bear on its pin a little label stating the place and date (at least month) where and when it was caught. Printed labels may be bought, or labels may be written with a very fine pen and should not be over three-eighths inch long and five-sixteenths inch wide. (Some scouts prefer bill-boards and paint brush for labels, but they won't get by the judges). Run the label up the pin to the height of the bottom step, or the second step of a three-step block. If there is a second label it is spaced at the height of the bottom step on a three-step block.

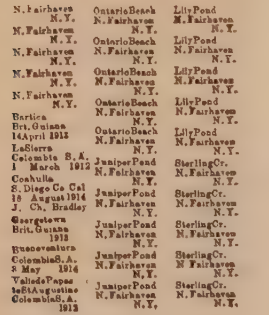


Fig. 100—*Locality-labels*

Fig. 101—*Arrangement of labels on the pin*

On the pin

Other labels

Some scouts like to have their name and the word collector printed on a second label. Also it is a good plan to have a label stating the kind of place where the specimen was caught, as "rose-leaf," "sunflower," "sand-bank," "stream," etc. The name is not put on a pin-label.

Special Directions for Moths and Butterflies

Moths and butterflies are much more trouble to collect in a workman-like manner than are other insects, and the scout will do better not to collect any until he

has attained a degree of skill with the others; unless he very especially prefers them to all others and particularly wants to. *Tough job*

The scales on the wings and body, which give moths and butterflies their colors, rub off at a touch. So the scout must never touch the specimen with his fingers. Handle them only with forceps. Never let them shake about in a bottle and rub amongst other specimens. *A moth shake*

Use a special bottle for moths and butterflies, and *never let another sort of insect be put in it.* It is best to pour a few drops of ether into the cyanide-bottle (right onto the plaster of paris, or onto some absorbent cotton). This kills them very quickly before they can struggle and beat their wings. When a specimen is dead, transfer it to another "storage" cyanide-jar. Keep this jar without shaking or rough usage until the specimens can be pinned. The first jar is ready then to kill the next specimen. *Quick death*

When you pin a moth, thrust a pin first through its side a little ways. This serves as a handle, by which to hold it while you pin it with the regular pin. When it is pinned, withdraw the handle-pin, and force the moth up on the pin by running the latter through a piece of paper, or cloth—the leg of your pants serves well enough. *Pretty slick!*

Of course some scouts won't do it this way for they just love to see their finger prints on the butterflies' wings, as proof positive that they and no one else caught them. *Finger prints*

When moth specimens are "bald" on the thorax it is a sure sign that you are treating them rough, and need to improve your technique. *Treat 'em rough*

Moths can be caught at night at lights, and by "sugaring." Mix molasses and water and paint it onto the trunks in the woods—just a dab on a tree. Note carefully the trees you paint, and visit them after dark.

from time to time, with a flashlight or lantern. You will see the moths sitting on the trees, sucking the dope, and can clap a bottle over them. This works best on a warm murky night, especially just before a storm. The mixture works best if fermented, and a few drops of asafoetida added seem to make it more attractive to the moths.

Sugaring

Butterflies are less trouble than moths. It does not hurt to hold them under the thorax between the fingers while pinning, and a quick pinch beneath the thorax while in the net will quiet a butterfly and prevent its fluttering in the cyanide-jar. But don't touch the wings.

Butterflies

Arranging the Collection

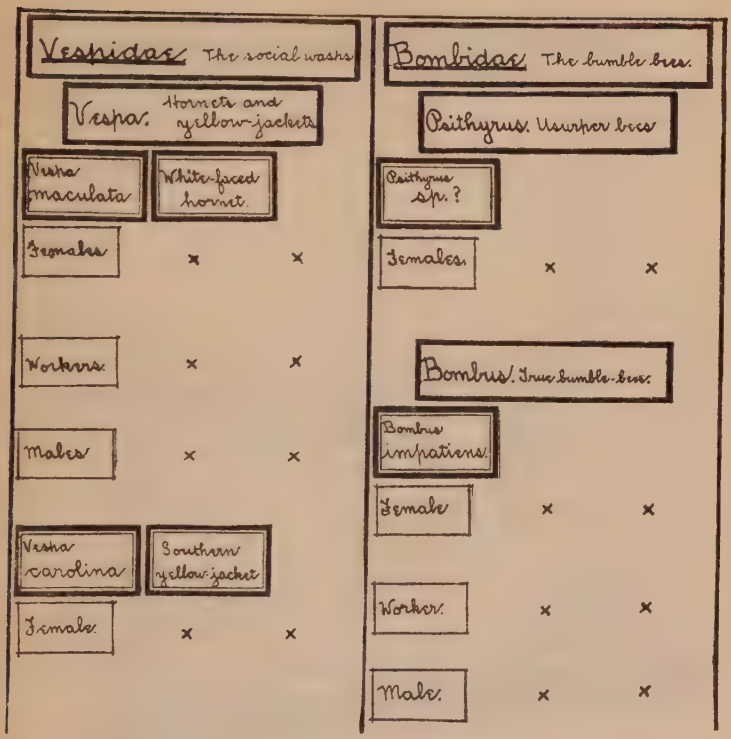
Get a cigar box and line the bottom with two layers of corrugated pasteboard, the corrugations of the pasteboard being arranged in one layer at a right angle to those of the other layer. Before putting in the top layer, cover it with white paper, pasting it on. It looks better to paste white paper around the sides of the box. Rule off the paper into columns, with heavy ink lines. The columns should be two and one-half inches wide or more. They must be wide enough to allow two or four specimens of each kind to be arranged side by side in a column beside the label, without crowding. Spread specimens can be arranged one behind the other.

Boxes

Cigar boxes let in buffalo carpet-beetles, which in time will destroy the collection. When they get in they can be killed by pouring in a little carbon tetrachloride or carbona cleaning fluid, and naphthalene flakes help keep them out. They are less apt to get into "New Era" boxes, but the best insect boxes are the wooden and cork-lined "Schmitt Boxes," into which pests rarely get.

Better boxes

The diagram shows how to arrange specimens and labels. The x-marks show where to pin the specimens. All family names end in -idae, making clear which are family labels. Some scouts may prefer to omit the



genus labels, since the genus name is also written on the species label; or if genus labels are used, the name of the genus can be abbreviated on the species label by using its first letter only, as *B. impatiens* instead of *Bombus impatiens*. If one does not use an extra label for the common name, space may be saved by pinning the specimens to the right of the species label. If you do not know the sex, omit sex labels. If you know the name of the genus, but not the species of a specimen, write *"Psithyrus sp.?"* which stands for *"Psithyrus* species?" and means one is in doubt about which species the specimen is. The width of the column must be increased for very large insects. Only one order of in-

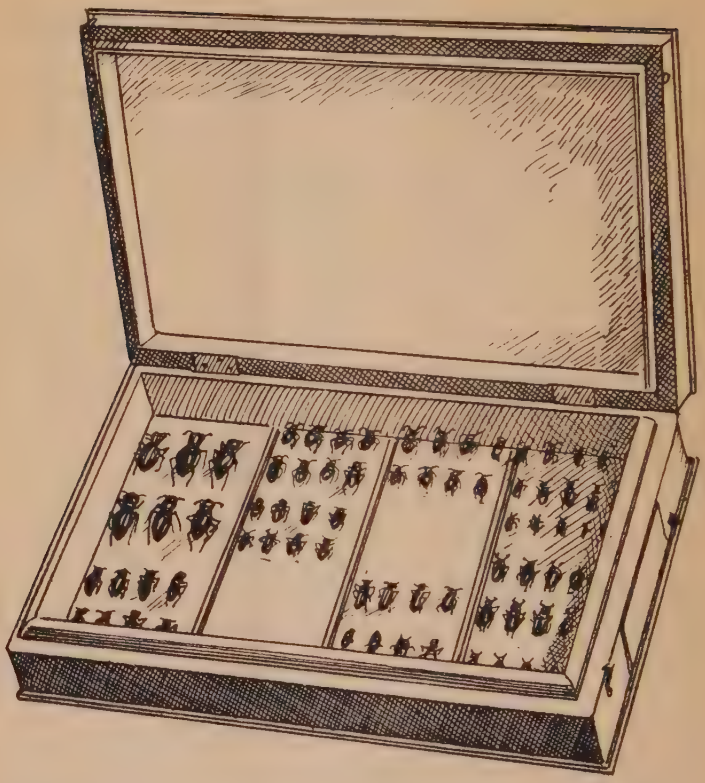


Fig. 102—*A Schmitt-box, showing method of arranging a collection in rows and columns*

sects should be put in the same box. The name of the order can be put on the outside of the box.

Family The name of each family of which you have specimens should be *neatly* written or printed on a family label, and placed in the center of the column in front of the specimens which belong to it.

Kind Of each kind (species) there should be, if possible, a male and a female (of bumblebees and ants, male, female, and worker), or better, two of each. Their name is

written on a species label, and pinned at the left of the specimens.

The illustrations show sample labels for family and kind. Entomologists use blank bordered labels, which may be purchased from dealers, into which they write in a careful hand the names. A scout may make his own bordered labels by ruling them with a pen—a ruling pen, if he has one, is best. Such labels add to the neatness of a collection, but are not necessary—plain paper can be used. The scout should either write or print his labels very carefully, in a vertical handwriting, or on a typewriter, or if he has a printing press, he can set them up in type.

Labels

In putting in labels, use short pins, known as ribbon-pins, or bank-note pins.

Pinning-forceps are very handy in inserting label-pins and insect-pins, but are expensive and not necessary.

The real names of insects are not hard to learn, after one gets used to them, especially if one is studying Latin. They are the best, because they mean something definite and are understood. Many insects and families of insects have been given English names, which may be used by those who prefer, but are not always in general use or understood in the same sense by others.

Oh, those Latin names!

All *kinds* of insects (species) belong to groups called genera (singular: genus). Very often the scout will have to content himself with the name of the genus, and not be able to make sure of the particular species.

Genera

Now go to it, and see how many kinds you can collect, how well you can mount them, and how many you can name, and how neatly arrange them.

We're off

DEALERS IN ENTOMOLOGICAL SUPPLIES

Ward's Natural Science Establishment, 84 College Ave., Rochester, N. Y.

Simplex Net Co., 6 Thurston Ave., Ithaca, N. Y. (nets only).

General Biological Supply House, 1177 East 55th St., Chicago, Ill.

Will Corporation, Rochester, N. Y. (pins, spreading-boards, nets).

McKay School Equipment, Limited, 265 Adelaide St., Toronto, Ontario, Canada.

Kny-Scheerer Corporation, 404 W. 27th St., N. Y. C.

*Staudinger & Bang-Haas, Blasewitz bei Dresden, Germany.

*Winkler & Wagner, Dittegasse 11, Wien XVIII, Austria.

MANUFACTURERS OF INSECT-PINS

*Rudolf Frisch, Karlsbad, Alta Wiese, Cecho-Slovenski Republic (manufacturer of "Ideal" steel pins).

DEALERS IN SILK BOLTING-CLOTH

Abbe Engineering Co., 220 Broadway, N. Y. C.

Any dealer in flour-mill machinery and supplies.

DEALERS IN BEE-KEEPERS' SUPPLIES

The A. I. Root Co., Medina, Ohio.

The W. T. Falconer Mfg. Co., Falconer, N. Y.

PRINTER OF PIN-LABELS

C. V. Blackburn, 32 Chestnut St., Stoneham, Mass.

DEALERS IN SECOND-HAND ENTOMOLOGICAL BOOKS AND PAMPHLETS

John D. Sherman, Jr., 132 Primrose Ave., Mt. Vernon, N. Y.

R. Friedlander & Sohn, Karlstrasse 11, Berlin N. E. 6, Germany.

* In view of the difficulty of obtaining good insect pins in this country and the high prices obtaining, collectors often buy them from abroad, and these addresses are given for those who may wish to do so.

CHAPTER V

REARING AN INSECT

REQUIREMENT NUMBER FOUR

Give evidence that he has bred through all its life stages at least one species of insect. Mosquitoes, blow-flies, cabbage-butterflies, and ants, are suggested as easy species to rear.

Any insect that the scout wishes may be used to satisfy this requirement. Its purpose in part is to learn by experience the manner of growth of insects, so the scout should read carefully the paragraphs on this subject on pages 2 to 6. He must be able to tell the examiner whether metamorphosis in the kind of insect he is studying is complete or incomplete. He should preserve in separate vials of denatured alcohol or 5% formalin, eggs, young and old larvae, and pupae of the insect that he chooses.

In fulfilling Requirement No. 11 the scout can easily obtain all stages in the growth of an ant. Or if he prefers, he may follow the directions given under the heading of mosquitoes under requirement No. I (2). Mosquitoes can be bred with almost no care or attention.

Blow-flies may be raised as follows: Buy one-quarter ounce of gum agar (agar-agar) at a drug store, soak it in part of a pint of water, then dissolve it by boiling in the remainder of the pint of water (it dissolves with difficulty) and put in a quarter-teaspoonful of beef extract, or a little blood, and pour it into a saucer. Expose it to the air until it is "blown"—that is until blow-flies have found it and laid patches of yellow eggs on it. If you watch you can see them do this. Then exclude the flies by laying a piece of glass over the saucer. The

By gum!

eggs will hatch, and the white maggots develop and can be easily watched in the gum. When they become pupa, they do so *inside* of the last larval skin, which becomes swelled up and brown and hard, and forms a good protection for the pupa within, taking the place of a cocoon. It is called a *puparium*.

Cabbage-worms and other kinds of caterpillars are more difficult to raise and take much longer. But they are perhaps more interesting. A good method is to grow a small plant in a flower-pot, or keep a bottle of water buried in a flower-pot, putting in fresh stalks from time to time. Set a lamp chimney over the plant or leaves and cover the top with cloth, tying it around with a string. In this way the caterpillars can be observed and kept confined.

If a living plant cannot be kept for the caterpillars, then they must be kept supplied with fresh leaves. Dr. F. E. Lutz, of the American Museum of Natural History, suggests the following excellent plan: Keep the caterpillars with leaves of their food-plant in a tightly closed fruit-jar; there will be air enough within for the caterpillars, but not enough to dry out the leaves, which will keep fresh quite a while. Very large caterpillars eat so many leaves that you are likely to tire of feeding them.

Hungry

CHAPTER VI

ABOUT ENTOMOLOGY AS A PROFESSION, AND ENTOMOLOGISTS

Entomology, as the study of insect-life is called, has two branches, the pure science of entomology and applied entomology. By the pure science we mean the study of the relationships of insects to each other, their structure, habits, transformations and classification. There are so many kinds of insects and their structure and habits have been so incompletely investigated that it is a continual fascination to study them. New facts are constantly being brought to light, new relations discovered, and the work of the investigator is full of surprises which bring to him real thrills of pleasure and delight.

Applied entomology, or economic entomology, as it is more often called, is the application of the knowledge gained in the pure science of entomology to combating the insect foes of man. It is evident that a wide knowledge of the pure science of entomology is necessary to become a successful economic entomologist, because economic entomology is entirely based on the facts gained in the pure science.

Recently the Government Entomologist of the United States, Dr. L. O. Howard, in an address to the assembled men of science of North America made the statement that the next great war for which we had really seriously to prepare was not a war between human beings alone, but between human beings and insects. Insects outnumber very many times all other creatures put together, and without anything to check them would soon destroy all of the vegetation of the earth. Dr. Howard pointed out that it is coming to be a real war between

us and them for a place to live upon the earth and for food to keep ourselves alive.

In his forthcoming "Manual of Injurious Insects," Professor G. W. Herrick will publish the following table, showing that the total loss caused by insects to agricultural interests in the United States during 1919 was as follows:

Products	Value in 1919	Loss by Insects
Farm Crops	$14,755,364,894	$1,475,536,489
Nursery	20,434,389	2,043,438
Greenhouse	77,380,230	7,738,023
Farm Forest	394,321,828	39,432,182
Animals	3,600,000,000	180,000,000
Forests	Estimated	100,000,000
Stored Grains	"	200,000,000
	Total Loss	$2,004,750,132

During the year 1922 there were 6,000,000 bales of cotton prevented from developing by the boll weevil, which at the average farm price of cotton during that year of 19 cents a pound, meant a loss of $570,000,000 to the cotton-growers.

"The Hessian fly in 1900 cost the wheat growers $100,000,000.

"The chinch-bug during the period from 1850 to 1909 caused a loss estimated as probably in excess of $350,000,000.

"The codling-moth causes the fruit growers of the United States an annual loss of over $12,000,000 and of New York, alone, more than $3,000,000.

"The annual loss to the people of the United States from malarial diseases carried by mosquitoes is not less than $100,000,000. The loss to agriculture and other industries as a result of malaria is enormous.

"The loss that has been caused by yellow fever, carried only by mosquitoes, cannot be estimated, but was certainly very great.

"Typhoid fever, due in large measure, at least, to its dissemination by the house-fly, causes a very great annual monetary loss.

"To the destruction occasioned by insects must be added the cost of fighting them.

"It is estimated that it costs $10,000,000 annually to spray for the San José scale.

"It costs $10,000,000 to screen against the house-fly.

During twelve months in 1922-23, the total expenditure in fighting the gypsy and brown-tail moths in New England was about $1,480,850, of which $531,000 was spent by the Federal Government, $487,000 by states and over $462,850 by municipalities, corporations and individuals.

Anyone who will stop to consider these very high money losses and fighting costs will realize that there is a demand for persons trained in the knowledge of insects to take positions in the army of men that is fighting these pests. They cannot all be generals, and none of them are likely to make a fortune in this sort of work, but there is good employment at reasonable wages for a really considerable number of men, and this number is bound to increase as the years go on and the war becomes intensified.

Every state maintains an Agricultural Experiment Station and in all of these states entomologists are employed, whose duty it is, as generals, to lead the war against the insects in their own state. They employ assistants and county agents who are in turn the captains and lieutenants. Some states have county entomologists as well as state entomologists. Some of the large fruit-growing and other agricultural industries maintain entomologists to fight the pests of their own particular crops, and some of the companies that deal in insecticides also employ their own entomologists. Then there is the United States Government with its great

Bureau of Entomology, which employs a large number of men to conduct all phases of the fight against insects in the United States as a whole.

In addition to the large number of men employed in directly fighting insects there is a lesser opportunity for persons to carry on researches and teaching in pure entomology. Many of the colleges of the United States give courses in entomology, and in all such teachers are, of course, necessary. Very often their work in teaching must also be combined with practical work in the control of insect pests. There is a still more limited demand as museum workers in the museums of the greater cities of the United States, for persons who have knowledge of the classification of insects.

It is not likely that any one choosing entomology as a profession with the idea of making himself wealthy or of making a great financial success of the undertaking will ever succeed but, on the other hand, he may reasonably expect to make a comfortable living, and that he will find an interest attached to his work which will last all his life, and which will compensate for the lack of greater financial remuneration.

A scout who wishes to become a professional entomologist should begin by making as good a collection of insects as he can, taking great pains to name them as fully and as accurately as he is able. The more he does of this sort of work, the more fun it becomes, and he is all the while learning facts about the innumerable kinds of insects and their classification that will be invaluable to him later on.

When he is through high school he must go to college. The opportunities for advancement are very limited to the man who is not a college graduate, because to be a first class entomologist one needs the things that he learns and the training that he gets in college. It is

not so difficult a matter for a scout to go to college these days. Nearly every really earnest boy can make the opportunity. Lots of boys work their way through our colleges, and many obtain scholarships of one sort or another. If you are really very much interested in insects and want to make their study your life work, write to a Professor of Entomology in one of the big universities mentioned below and ask his advice. The writer of this pamphlet would be always happy to hear from such scouts. It is also important, when you go to college, to get a broad training in sciences and languages, and not to specialize too early nor too continuously. A knowledge of German and French are very important.

The day has gone when the "bug-hunter" was looked upon as a sort of crazy crank who dashed around fields with a butterfly net and spent his time in a useless hobby. The entomologist of today is a highly trained individual, very necessary to society, and his life is usually a pleasant one, for his activities bring him into contact with other scientists, with agriculturalists, with medical men, and others who are doing worth-while things, and he is likely to be located in a college community, with its pleasant and inspiring associations.

The number of kinds of insects is so enormous that at first their study seems overwhelming, and all uphill work. Gradually one begins to get a grasp of the subject; one seems to have reached the crest of the hill, and there unrolls a panoramic view. By eventually confining your more serious study to a limited group of insects, it becomes possible, by and by, to know more about that particular group than any one else in the world, and thus to achieve the pleasant satisfaction of becoming *the* world authority, and to feel that your work is definitely contributing to the cumulative knowledge of mankind, and to the slow, steady progress of science.

Very many universities and colleges, especially the agricultural colleges, give courses in entomology, and one can get the fundamental training necessary in any of them, coming to the more especial entomological centers for his final training, perhaps for graduate work. But there are some institutions that make more of a specialty of teaching entomology than others. Cornell University has led the way in developing a department of entomology, and has trained very many of the professional entomologists of the country. When Professor Comstock was made Assistant Professor of Entomology at Cornell in 1877 he was practically the first professor of entomology that had ever been appointed at any institution in the world. Now the department has a staff of sixteen individuals engaged in entomological teaching, research or curatorial work, eight of whom are professors. Massachusetts Agricultural College has had a department of entomology for very many years. The University of Illinois has at present an entomological staff of nine, five of whom are professors. The Universities of Minnesota, Ohio, Kansas, and California, Iowa State Agricultural College and Leland Stanford University all have important entomological departments, and Harvard University has at its Bussey Institution a very important graduate school of entomology.

CHAPTER VII

SKETCH OF THE LIFE OF JOHN HENRY COMSTOCK

By Simon Henry Gage, Professor of Histology and Embryology, Emeritus, in Cornell University

If as free wandering souls before birth we had a chance to select our parents and the place where we wished to be born on the earth, would we choose parents who had only their strong arms and stout hearts, and who lived in a pioneer country where comforts were few and hardships many? Fortunately there is no choice and the subject of this sketch, John Henry Comstock, first saw the light in the village of Janesville, Wisconsin, in 1849, a year after Wisconsin had been admitted into the Union as a State.

When he was about three years old the lure of California gold started the father with a party to find the fabulous wealth, but cholera appeared in their ranks and claimed the father long before he reached the El Dorado of his hopes. This left the mother with scant resources, but she belonged to the family line of Ethan Allen, a family not easily overwhelmed either by success or failure. She returned to her native State, New York; and then began the struggle for bread. It became necessary for mother and boy to separate, the little boy going to an orphan asylum. Later he was taken into a family where there was enough to eat whatever else might have been lacking. When sixteen years old the young man became a sailor on the great lakes for the good people among whom he was brought up were sailors.

Of course every boy scout learns to climb trees, and the joy of swaying in the wind from a tree top or out on the end of a long limb, is one of the unforgetable experiences of life. But suppose that the earth also commenced to heave and sway, that would certainly add to the thrill. Well, our young sailor up the mast or out

on the end of a yard arm with the wind in the rigging and the dark waters below rolling in gigantic waves, got the added thrill. Such experiences are pleasanter to read about in a cozy room or by a cheerful camp-fire than to go through.

Verily those whom the gods love most they "treat rough." That seems to be the surest way of giving them sinews of steel and brains of power.

In the winter months there was opportunity for school, and later for teaching in the country schools. He had a love for all learning, but nature had a great fascination for him. The plants with their beautiful flowers appealed first, but all plants do not have flowers. There were the ferns, the lichens and mosses and many others that seemed very interesting and he wanted to know about them, too. So one day when in the harbor at Buffalo he went to a book store to find some work on plants without flowers. He did not find the book on cryptogamic botany, but on the shelf of natural history works in the back of the store was a copy of Harris' Insects Injurious to Vegetation. Its author was the librarian of Harvard College, and the beautiful colored plates and single pictures in the text and had been drawn from nature under the supervision of the great Louis Agassiz. This opened a new world to the young sailor. He asked the price. It was $10.00, alas too much for him! Did he give it up? Hardly, with the blood of the Allens in his veins. He went to his captain and drew from his small wages the needed money and the next day, July 2, 1870, he secured the coveted volume. As he showed the identical book to the writer fifty-three years afterward he said: "And that book made an entomologist of me."

Any red-blooded boy might fairly ask: "Why should anyone study bugs, when there are gorillas, elephants, whales and hundreds of other animals on land and in

the water big enough to amount to something?''

Well, in answer it may be said that it is not always the biggest things that are the most interesting on the one hand or the most intelligent on the other.

The more we know about the insects the more are we impressed by what the group has accomplished. In time, the insects began to appear on the earth in the Carboniferous Period, aeons ago, so they certainly are ''one of the first families''; and as to numbers, our own time might properly be called the ''Age of Insects,'' as there are more species of insects than of all the other animals combined, and the individuals are about as numberless as the sands of the sea.

In resourcefulness, too, they have outstripped all other groups. They learned to fly millions of years ago, and they did not have to use a gas engine for it either, and some of them have their own headlights of genuine ''cold light.'' They learned to live either in air or in water, and their architecture fills one with admiration. Some of them found individualism the best way to live, while others perfected community life beside which human society is simply chaos. They learned how to control the sex and the number of their offspring, and how in one stage of life to be worm-like creatures and in another gorgeous denizens of the air. Their realization of beauty by perfect form combined with harmonious, often the most brilliant, coloration both by the use of pigments and by structural coloration has never been equaled by any other group. They have learned all the bad things, too, such as war, murder, robbery, slavery, parasitism. Now why should not a boy want to know about creatures that have tried everything imaginable and succeeded in it all?

But to return to the young man. By being a sailor part of the time and a student all the time, he was ready to enter college when about 20 years old, and he

chose the new institution, Cornell University, on the shores of Cayuga Lake. It offered opportunities to work and help pay one's way. And then there were many different courses leading to degrees. In one group mention was made of collections of insects and instruction concerning them. He found the opportunity to labor, and helped build the college hall where afterward he gave his lectures and laboratory work. He found also inspiring teachers, and kindred spirits among the students, but the time given to the study of insects was of necessity very small. He himself was destined to become the creator of the Department of Entomology in the new University. It began in this way: In the spring of 1872 thirteen of his college mates petitioned the faculty to have Comstock give them a course in entomology that term. The request was granted, and from that day to this the work in entomology has followed the same plan:—Lectures to discuss principles and give a broad outlook, and then field and laboratory work in which the student comes face to face with the insects themselves and their work and ways. Everyone has had the chance to get knowledge at first hand, and what a splendid group of men and women have gone out from that instruction to pass on the torch of knowledge, and independent thinking!

From student, assistant, and instructor, 1872-1876, he became assistant professor in 1876 and full professor in 1882. In 1914, at the age of sixty-five, he retired and became an emeritus professor after over forty years of service to the University. For many years he did all the work of instruction in lectures, field and laboratory work. Room and equipment were slow in becoming adequate, but they came as all things come to him who works and waits. When he retired the department had a splendid material equipment and adequate room, and instead of one teacher there were twenty-nine, and a

librarian and curator besides. On his retirement, as a token of their appreciation, his old students presented a fund to the University for a Comstock Memorial tions made possible with the income of the fund the Library in Entomology. This is now one of the best entomological libraries in the country and by the addi- library will increase from year to year and keep pace with the growth of knowledge.

What tribute could be more fit as a memorial to a teacher than an ever growing library in the field to which he had devoted his life!

It would not be right nor true to leave an impression that Professor Comstock cared for nothing and studied nothing except entomology and found out everything himself. No, he took very broad courses in the University, striving to see the sum of human knowledge from all angles and at all standpoints. He took advanced courses in Harvard University and at Yale, and in the University of Leipzig. Perhaps if but a single word were used, his watchword has been "thoroughness." Expressed by himself, the guiding principle of his life and the one urged upon his students is this: "*Be sure you are right, and then look again.*" Failure is impossible if one follows this guide.

Not only did Professor Comstock teach and direct advanced students, but he wrote books on insects and spiders, and no works in natural history during his lifetime have had more beautiful and accurate pictures, many of which were wood-engravings by Mrs. Comstock. Besides books he wrote many scientific papers in which he told about the things which he had discovered. No truly great man leaves the information about the subject he works upon where he found it. He adds to the knowledge already gained, and often has to correct the mistakes of others who *failed to look again* when they thought they were right.

Professor Comstock naturally became a member of the scientific societies of America and always took a leading part in those pertaining to his subject. He also served his country as United States Entomologist while on leave from the University in 1879 to 1881. The appreciation of his work by his European colleagues is shown by the fact that he was elected as honorary fellow of the Entomological Society of London, and member of the Société Entomologique de France. A fine tribute was paid him by President David Starr Jordan of Leland Stanford University who invited him to organize a Department of Entomology in that University at its beginning, similar to the one he had developed at Cornell. President Jordan was one of the college mates, mentioned above, who petitioned the Cornell faculty in 1872 for that beginning course in entomology, and he had followed with sympathetic interest all that had come from it, and he wanted a department like it in Stanford. Professor Comstock undertook the work in his long vacations from 1891-1900. Judging from the results, his creative and organizing powers were undiminished.

He is still at work on his beloved subject and is writing a book which he calls, "An Introduction to Entomology." It is dedicated to his old students in these words: "To my old students whose youthful enthusiasm was a constant inspiration during the long period of my service as teacher, this effort to continue to aid them is affectionately inscribed."

At this work we will leave him and let every boy answer for himself whether he thinks it was worth while for Mr. Comstock to study Entomology.

Ithaca, January 25, 1923.

CHAPTER VIII

BIBLIOGRAPHY

A SELECTED LIST OF BOOKS ON INSECTS OF INTEREST TO SCOUTS

Most of the books entered in this list are works of reference, to which one turns to find certain facts or directions that he may wish to know. Very often they have to state their facts in technical language. Sometimes they do anyhow.

Several, distinguished by an asterisk (*) are readable stories of insect life, that anyone will find interesting to sit down and read. These are non-technical in their language.

Besides the books listed below, every State Agricultural Experiment Station publishes pamphlets dealing with injurious insects, which may be had, as long as they are in print, for the asking. The United States Department of Agriculture publishes very many such pamphlets, lists of which may be obtained from them, or from the Superintendent of Documents, Washington, D. C., who sells them to the public after the free copies belonging to the Department of Agriculture are exhausted.

This bibliography does not pretend to completeness, but is a selected list of the books that, in the opinion of the authors, are likely to be the most useful and accessible to scouts.

THE CLASSIFICATION OF INSECTS

Books for Finding the Names of Orders and Families

1. Comstock, John Henry. An Introduction to Entomology. By John Henry Comstock, Ithaca, N. Y., The Comstock Publishing Co., 1920 (i.e. 1924). xxii, 1044 p. illus. $6.00

   This is the most authoritative and standard work for the beginner on general classification. Keys for determining the orders and families of insects are given, with a discussion of the habits of a few common representative species under each important family. It is a completely rewritten revision of the author's Manual for the study of insects, which has been the standard American textbook for a generation.

2. Kellogg, Vernon Lyman. American insects. By Vernon L. Kellogg. New York, Henry Holt & Co., 1905. 1 p. l., viii, 674 p. front, illus., 13 pl. (part col.). $5.00.

Less useful than the foregoing, this work consists of a general account of the orders and families of insects, with more stress upon the western species than in the case of Comstock's Manual.

Books for Finding the Names of Species or Kinds

Insects in General

3. Beard, Daniel Carter. American boy's book of bugs, butterflies and beetles. By Daniel Beard . . . New York, Lippincott & Co.

4. Lutz, Frank Eugene. Field book of insects, with special reference to those of northeastern United States, aiming to answer common questions. By Frank E. Lutz. New York and London, G. P. Putnam's Sons, 1918. x, 510 p. 101 pl. (part col.). Revised ed., $3.50

The best work for finding the names of insects in general.

5. Howard, Leland Ossian. The insect book. A popular account of the bees, wasps, grasshoppers, flies and other North American insects, exclusive of the butterflies, moths and beetles, with full life histories, tables and bibliographies. By Leland O. Howard . . . New York, Doubleday, Page & Co., 1901. xxx, 430 p. illus., plates (part col. with front). $5.00.

Moths and Butterflies

6. Comstock, John Henry *and* Comstock, *Mrs.* Anna Botsford. How to know the butterflies. A manual of the butterflies of the Eastern United States. By John Henry Comstock . . . and Anna Botsford Comstock . . . New York, D. Appleton & Co., 1904. xii, 312 p. col. front, 45 col. pl. Out of print.

The best work for naming the butterflies east of the Mississippi River.

7. Comstock, *Mrs.* Anna Botsford. The common butterflies, an outline for nature-study. Anna Botsford Comstock . . . Ithaca, N. Y., The Comstock Publishing Co., 1917. 1 p. l., p. 217-252, incl. front, illus. 25 cents, paper bound.

8. Holland, William Jacob. The butterfly book; a popular guide to a knowledge of the butterflies of North America. By W. J. Holland . . . New York, Doubleday, Page & Co., 1905. First edition in 1898. xx, 382 p. 48 col. pl. $5.00

Practically all of the butterflies of North America are illustrated in color.

9. Holland, William Jacob. The moth book, a popular guide to a knowledge of the moths of North America. By W.

J. Holland . . . New York, Doubleday, Page & Co., 1903. xxiv, 380 p. illus., 48 col. pl. incl. front $5.00.

From the colored plates, the names of nearly any North American moth may be determined, excluding the smaller species known as "micros."

10. Holland, William Jacob. The butterfly guide; a pocket manual for the ready identification of the commoner species found in the United States and Canada. By W. J. Holland . . . Garden City, New York, Doubleday, Page & Co., 1920. 238 p. 295 col. figures. $1.25.

A handy pocket-sized field manual.

11. Wright, William Greenwood. The butterflies of the west coast of the United States. By William Greenwood Wright . . . San Francisco, The Whitaker and Ray Co., 1905. 258, ix p. front. 32 col. pl. Out of print

From the colored plates, the butterflies of the Pacific Coast may be determined.

12. Weed, Clarence Moore . . . Butterflies worth knowing. By Clarence M. Weed . . . Garden City, New York, Doubleday, Page & Co., for Nelson Doubleday, Inc., 1922. xiv, 286 p. illus., 48 pl. (part col.) $1...

Beetles

13. Blatchley, Willis Stanley. An illustrated descriptive catalog of the Coleoptera or beetles (exclusive of the Rhyncophora) known to occur in Indiana, with bibliography and description of new species. By W. S. Blatchley . . . Indianapolis, The Nature Publishing Co., 1910. 1386 p. illus. $7.50.

A reference work, with many excellent illustrations very useful to the advanced student, but too technical in treatment for the novice,

14. Blatchley, Willis Stanley *and* Leng, Charles William. Rhyncophora or weevils of Northeastern America. By W. S. Blatchley and C. W. Leng . . . Nature Publishing Co., Indianapolis, 1916. 682 p. illus. $6.00

These two works, taken together, form the only existing manual of the beetles of the eastern United States. Their technical keys and descriptions are useful to only the advanced student, but the many illustrations and the records of habits, abundance, and the classification, make them invaluable for reference to anyone seriously interested in beetles.

Orthoptera (i.e., Grasshoppers and Their Kin)

15. Blatchley, Willis Stanley. Orthoptera of northeastern America, with especial reference to the faunas of Indiana and Florida. By W. S. Blatchley . . . Indianapolis, The

Nature Publishing Co., 1920. 784 p. front., illus. $6.00; paper, $5.00.

This is a manual for the study of the Orthoptera of eastern North America and while the keys and descriptions are necessarily technical, it is indispensable for the study of these insects.

17. Pettit, Rufus H. *and* McDaniel, E. . . . Key to the Orthoptera of Michigan, with annotations. By R. H. Pettit and E. McDaniel. East Lansing, Mich., State Agricultural College, 1918. 48 p. illus. (Michigan Agricultural College. Special Bulletin No. 88). Free.

18. Ruggles, Arthur Gordon. The Acrididae [*i.e.*, Locustidae] of Minnesota. By A. G. Ruggles. St. Paul, University of Minnesota. 98 p. col. pl. (Agricultural Experiment Station of the University of Minnesota, Technical Bulletin No. 141). Free.

Good color plates of Minnesota short-horned grasshoppers.

Gall-Insects

20. Felt, Ephraim Porter . . . Key to American insect galls. By Ephraim Porter Felt . . . Albany, University of the State of New York, 1918. (3)-310 p. illus., 16 pl. (New York State Museum Bulletin No. 200). Out of print.

In this work nearly every kind of gall is figured, and in the text arranged according to the plant they are found on with explation of the differences between the kinds.

Flies

21. Williston, Samuel Wendell. Manual of North American Diptera. By Samuel W. Williston. Third edition. New Haven, James G. Hathaway, 1908. 406 p. illus., pl. Out of print.

A technical manual for determining the genera of North American flies, but the numerous good figures will help even the novice to recognize many.

22. Alexander, Charles Paul . . . The Craneflies of New York. Part 1, Distribution and taxonomy of the adult flies. Charles Paul Alexander . . . Ithaca, N. Y., published by the University, 1919 1 p. l., 767 - 767 - 994 p. incl. 1 pl. (Memoir 25, Cornell University Agricultural Experiment Station). Out of print.

This is a technical work, but will help an advanced student in determining the names of crane-flies.

Mosquitoes

23. New Jersey Agricultural Experiment Station. The mosquitoes of New Jersey and their control. By Thomas J. Headlee . . . New Brunswick, N. J., 1921. 230 p. illus., diagr. (New Jersey Agricultural experiment station, Bulletin 348). Free.

Contains both technical and non-technical keys for naming mosquitoes, the ranges of which include New Jersey.

Spiders and Scorpions

24. Comstock, John Henry. The spider book. A manual for the study of spiders and their near relatives, the scorpions, pseudoscorpions, whip-scorpions, harvestmen, and other members of the class Arachnida, found in America north of Mexico, with analytical keys for their classification and popular accounts of their habits. By John Henry Comstock . . . New York, Doubleday, Page & Co., 1912. xvi, 722 p. front., illus., 1 col. pl. $5.00.

This is the best existing book on spiders.

THE HABITS OF INSECTS

Insects in General

25. *Comstock, *Mrs.* Anna Botsford . . . Ways of the six-footed. By Anna Botsford Comstock . . . Boston, New York, etc., Ginn & Co., 1903. xii, 152 p. $.60.

A very interesting and readable account of the habits of a few insects.

26. Comstock, John Henry. Insect Life, an introduction to nature study and a guide for teachers, students and others interested in out-of-door life. By John Henry Comstock . . . New York, D. Appleton & Co., 1897. 3 p. l., 350 p. illus., plates. $4.00.

Edition in 1905 with 18 plates, many colored.

27. *Fabre, Jean Henri Casimer. The life and love of the insect. By J. Henri Fabre. Translated by Alexander Texeira de Mattos. London, Charles Black, 1911. xii, 262 p. front., illus. 12 pl. $3.00.

Tells about the habits of scorpions, some bees, wasps, and weevils, and about tumble-beetles of several kinds.

28. *Insect Life; Souvenirs of a naturalist. By J. H. Fabre . . . Translated from the French by the author of "Mademoiselle Mori" (M. Roberts) with a preface by David Sharp . . . and edited by F. Merrifield, with illustrations by M. Prendergard Parker . . . London, MacMillan & Co., 1901. xii, 320 p. front., pl.

Mostly about wasps, with some chapters on bees and on scarab beetles.

29. *The sacred beetle and others. By J. Henri Fabre. Translated by Alexander Texeira de Mattos, with a preface by the author. New York, Dodd Mead & Co., 1918. xxiv, 426 p. $2.50.

* In addition to the books listed here, nearly all of those listed under classification treat briefly of the habits of the kinds referred to.

30. *The mason-bees. By J. Henri Fabre. Translated by Alexander Texeira de Mattos . . . New York, Dodd Mead & Co., 1914. viii, 316 p. $2.50.

Tells about mason-bees and their parasites.

31. *The life of the grasshopper. By J. Henri Fabre. Translated by Alexander Texeira de Mattos . . . New York, Dodd Mead & Co., 1917. viii, 454 p. $2.50.

Tells about some grasshoppers, crickets, cicadas, locusts, mantids and spittle-insects.

32. *The life of the fly; with which are interpolated some chapters of autobiography. By J. Henri Fabre. Translated by Alexander Texeira de Mattos . . . New York, Dodd Mead & Co., 1918. 477 p. $2.50.

Besides several kinds of flies, there is a chapter on insects and mushrooms, on pond life, and on caddis-worms.

These six volumes are by a French entomologist who devoted his life to the study of the habits of insects. He writes of what he has learned and observed in a thoroughly interesting, entirely non-technical manner, and has won for himself a real place in literature by them, and the appellation of "The Insects' Homer."

33. *Hancock, Joseph Lane. Nature sketches in temperate America. A series of sketches and a popular account of insects, birds, and plants, treated from some aspects of their evolution and ecological relations. By Joseph Lane Hancock . . . Chicago, A. C. McClurg & Co., 1901. xviii, 451 p. incl. front., plates. Out of print.

34. *Patch, Edith Marion. A Little Gateway to Science; Hexapod Stories. By Edith Marion Patch. Boston, The Atlantic Monthly Press, 1920. xviii, 180 p. $1.25.

Well told insect stories for younger scouts.

Ants

35. *McCook, Henry Christopher. Ant communities and how they are governed; a study in natural civics. By Henry Christopher McCook . . . New York and London, Harper & Brothers, 1909. xx, 322 p. front., illus. $2.00.

A book that every scout should read. Tells about how ants make war; their engineering methods; how they communicate; their slave-making; their guests; their cattle, and many other interesting things.

36. Wheeler, William Morton . . . Ants, their structure, development and behavior. By William Morton Wheeler . . . New York, Columbia University Press, 1910. xxvi, 664 p. illus., front. (Columbia University biological series, IX). $5.25.

A somewhat technical treatment of the extraordinarily interesting habits of ants and their guests.

Bumblebees

37. *Sladen, F. W. L. The humble-bee, its life history and how to domesticate it, with descriptions of all the British species of Bombus and Psithyrus. By F. W. L. Sladen . . . London, MacMillan & Co., Ltd., 1912. xiv, 284 p. front., illus., 6 pl. (part. col.). $5.00.

Dr. Sladen devoted his life to studying the habits of bumblebees. His book is one of the most fascinating stories of insect life ever written.

Honey-bees

38. *Morley, Margaret Warner. The honey-makers. By Margaret Warner Morley . . . Chicago, A. C. McClurg & Co., 1899. viii, (9) - 424 p. illus. $1.35.

A readable account of the ways of honey-bees.

Wasps

39. Peckham, George Williams *and* Peckham, *Mrs.* Elizabeth Gifford. Wasps, social and solitary. By George W. Peckham and Elizabeth G. Peckham, with an introduction by John Burroughs; illustrations by J. H. Emerton . . . Boston and New York, Houghton, Mifflin & Co., 1905. xiv, 310 p. incl. front., illus., plates.

40. *Morley, Margaret Warner . . . Wasps and their ways. By Margaret W. Morley . . . New York, Dodd, Mead & Co., 1901. 316 p. incl. front., illus.

Orthoptera (i.e., Grasshoppers and Their Kin)

41. *Morley, Margaret Warner. Grasshopperland. By Margaret Warner Morley . . . Chicago, A. C. McClurg & Co., 1907. 282 p. incl. front., illus Out of print.

Flies

42. Alexander, Charles Paul. The Craneflies of New York. Part II, Biology and Phylogeny. By Charles Paul Alexander. Ithaca, New York, published by the University, 1920. 2 p. l., 695 - 1134 p. incl. pl. (Memoir 38, Cornell University Agricultural Experiment Station). Out of print.

Tells what is known about the habits of these insects.

Mosquitoes

43. Howard, Leland Ossian. Mosquitoes, how they live; how they carry disease; how they are classified; how they may be destroyed. By L. O. Howard . . . New York, McClure, Phillips & Co., 1901. xviii, 242 p. front., illus.

Spiders

See item number 24, on page 167; especially Chapter IV: "The life of spiders."

Injurious Insects

44. Crosby, Cyrus Richard *and* Leonard, Mortimer Demarest. Manual of vegetable-garden insects. By Cyrus Richard Crosby and Mortimer Demarest Leonard . . . New York, The MacMillan Co., 1918. xvi, 392 p. $2.75.

46. Herrick, Glenn Washington . . . Insects injurious to the household and annoying to man. By Glenn W. Herrick . . . New York, The MacMillan Co., 1914. xviii, 470 p. illus. (The rural science series). $3.00.

46a. Herrick, Glenn Washington . . . Manual of injurious insects . . . Henry Holt and Co. In press.

47. Riley, William Albert *and* Johannsen, Oscar Augustus . . . Handbook of medical entomology. By W. A. Riley and O. A. Johannsen . . . Ithaca, N. Y., Comstock Publishing Co., 1915. x, 348 p. illus.

An account of the part played by insects in the transmission of disease.

48. Slingerland, Mark Vernon *and* Crosby, Cyrus Richard. Manual of fruit insects. By the late Mark Vernon Slingerland and Cyrus Richard Crosby . . . New York, The MacMillan Co., 1914. xviii, 504 p. illus. $3.50.

PROBLEMS OF APPLIED ENTOMOLOGY

49. Brues, Charles Thomas . . . Insects and human welfare. An account of the more important relations of insects to the health of man, to agriculture and to forestry. By Charles Thomas Brues . . . Cambridge (Mass.), Harvard University Press, 1920. xii, 104 p. illus. $2.50.

A discussion of the broader problems of applied entomology and outlook for the future.

DIRECTIONS FOR COLLECTING INSECTS

50. Banks, Nathan. Directions for collecting and preserving insects. By Nathan Banks . . . Washington, Government Printing Office, 1909. xiv, 136 p. front., illus.

(Smithsonian Institution. United States National Museum. Bulletin 67). Out of print

BEE-KEEPING

51. Comstock, *Mrs.* Anna Botsford . . . How to keep bees; a handbook for the use of beginners. By Anna Botsford Comstock . . . New York, Doubleday, Page & Co., 1905. x, 288 p. front., 31 pl. $1.60.

52. Rowe, H. G. Starting right with bees . . . Medina, Ohio, A. S. Root Co., 1922. 128 p. illus. $1.00.

This little pamphlet is the best non-technical guide of which we know for the scout who is a novice at bee-keeping.

APPENDIX A

COMMON KINDS OF INSECTS OF WHICH ANY SCOUT CAN FIND AND NAME FIFTY

1. Biting Flies.

A. *Horse-flies, deer-flies, green-headed flies, yellow-flies.* Family Tabanidae.

(*a*) Very large, ¾ in. to 1 in. long; all black. Eastern. *Tabanus atratus.*

Fig. 105 — *Tabanus atratus*

Fig. 106 — *Tabanus lasiophthalmus*

Fig. 107 — *Chrysops*

(*b*) Very large, 1 in. long; color above dark cherry-red brown. Southeastern. *Tabanus americanus.*

(*c*) Very large, ¾ in. to 1 in. long; color dark cherry-red brown. California. *Tabanus aegrotes.*

(*d*) Other horse-flies, about ½ in. long; belong to genus *Tabanus*, of which there are many species which are not easily named.

(*e*) If smaller and with eyes that show intricate designs in rainbow colors, some with black-blotched wings, they are *Chrysops* of various species. Swarm in woods and swamps, *light on person's head, neck, and temples, and bite.*

(*f*) The yellow-fly, abundant in swamps along the Gulf and South Atlantic coasts, and a fierce biter is *Diachlorus femoratus.*

B. *Black flies.* Abundant in northern woods in early summer. Crawl over hands and face and draw blood. Smaller than house-fly. See page 73. *Simulium.*

2. Other Flies.

A. *Very large, thick flies, 1 in. or more long; antennae ending in a knob.* Black with a red band at base of abdomen; wings black. Southern. Family Mydaidae. Genus *Mydas.*

B. *House-flies.*

(*a*) Tongue fleshy and enlarged at tip. Light on food and lap it up. Found everywhere. True house-fly. Family Muscidae. *Musca domestica.*

(*b*) Looks like a house-fly, but tongue is sharp and pointed, and instead of lighting on food, it lights on you and bites. Color ash-grey. The stable-fly, also called biting house-fly. Family Muscidae. *Stomoxys calcitrans.*

C. *Blue-bottle fly and blow-flies.* Lay eggs on meat. To get some expose some raw meat in the open. Found everywhere. Family Muscidae.

Fig. 108—*A blow-fly, Lucilia caesar, enlarged*

(*a*) Face between the eyes white. Body very green. *Lucilia caesar.*

(*b*) Face between the eyes white. Body greenish, but with a bronzy tint. *Lucilia sericata.*

(*c*) Face between the eyes white. Body blue. *Lucilia sylvarum.*

(*d*) Other common kinds, face not white, are *Calliphora* and *Phormia.*

D. *Dung-flies.* Common, flying about or lighting on cow-dung. Moderately large, yellow in color, rather hairy, slender, with longish legs. Found everywhere. Family Scatophagidae. Genus *Scatophaga.*

E. *Fruit-flies.* To attract these expose to the open for a day or two some decaying fruit. Soon little yellow flies will be seen flying about and crawling over it. Much smaller than a house-fly and with *pink eyes.* Found everywhere. Family Drosophilidae. Genus *Drosophila.*

3. Bees.

A. *Honey-bee.* Found everywhere. In the males the eyes join above. *Apis mellifica.*

B. *Carpenter-bees.*

(*a*) Big carpenter-bee, looks like a bumblebee, but bores in posts, etc. Bumblebees never do this. Hind legs with a brush of hair all around them in female (unlike those of bumblebees). Genus *Xylocopa.* Males have large eyes and white face. In north there is only one kind, black, thorax covered with yellow hair, *Xylocopa virginica.* In southeast another kind also, the male green-blue, its thorax and base of abdomen with short sparse yellow hairs; the female all blue, *Xylocopa micans.* In south-

west other species, steel-blue; some have male all yellow. See also under Requirement No. 1:5 (a), page 89.

(*b*) Little carpenter-bee. See under Requirement No. 1:5 (a), page 37. Genus *Ceratina*.

C. *Sweat-bees*, very small. For *Halictus*, which can be recognized by their nesting habits, see under Requirement No. 1:5 (a), page 40. All metalic green, abdomen *convex* beneath. Genus *Augochlora*. Common everywhere. (If the abdomen is *concave* beneath, they are not bees, but are cuckoo-wasps, family Chrysididae). Head and thorax metallic green, abdomen banded black and yellow. Genus *Agapostemon*.

D. *Bumblebees*, genus *Bombus* and *Usurper bees*, genus *Psithyrus*. For distinction, see under Requirement No. 1:5 (b), page 55.

4. Wasps, Hornets, Yellow-Jackets, Etc.

A. *Nests made of paper;* many wasps in one nest. Family Vespidae.

(*a*) Nest an open comb. Common everywhere. Paper-wasps, called in the south guinea-wasps. Genera *Mischocyttarus* (abdomen with a stalk at base, south and west) and *Polistes* (abdomen not stalked. Every part of U. S.). Males have yellow faces and more slender, straight feelers. Some kinds may be recognized as follows:

(1) In California common species is black and bright yellow. *Polistes aurifer.*

(2) In Southern California, Arizona, Texas, etc.; the common species is yellow all over, the wings clear. *Polistes texanus.*

(3) Another one in Arizona is yellow and brownish, the wings dark brown, antennae brown, tipped with orange. *Polistes navajoe.*

(4) In southeast, a large species; all of a ruddy reddish color, dark wings, very common. *Polistes rubicundus.*

(5) In southeast, a much smaller kind, reddish and much banded with yellow. *Polistes bellicosus.*

(6) In east and southeast, a large brown species, with dark wings, brown feelers which are tipped with orange, and first segment of abdomen has a yellow band. Builds large combs which often overhang streams in the south. *Polistes annularis.*

(7) In the northeast the only other species (and the only species in Central New York) is smaller, all brown, or with narrow yellow stripes and reddish spots on the abdomen, but without orange tips to its feelers. *Polistes pallipes.*

(8) In south Georgia and Florida, small, yellow and black or reddish-banded, but *first segment of abdomen forming a stalk.* Makes small nests, often on palmetto leaves. *Mischocyttarus cubensis.*

(9) In southwest, California and Colorado. Same characters as above, but larger. *Mischocyttarus flavitarsis.*

Fig. 109—*A paper-wasp, Polistes pallipes*

Fig. 110—*The white-faced hornet, Vespa maculata*

(*b*) Paper nests, but closed with an outer paper shell. Hornets and yellow-jackets. Found everywhere except in the desert and plains. Genus *Vespa.*

(1) Around New York City, Long Island, etc. Very large, brown and yellow. European hornet. *Vespa crabro.*

(2) Everywhere. Black and white; feelers *rust-colored beneath.* White-faced hornet. *Vespa maculata.*

(3) Other hornets and yellow-jackets.

(A) Black and white; eyes not reaching to base of jaws, a part of the cheek being between them. *Vespa arctica.*

(B) Black and white; eyes reach the jaws. *Vespa consobrina.*

(C) Black and yellow; middle of back of thorax has two yellow lines running lengthwise.

(a) Southeastern States. *Vespa carolina.*

(b) Western States. *Vespa sulphurea.*

(D) Black and yellow; middle of back without two yellow lines as above.

(a) Lives on Pacific Coast only. *Vespa occidentalis.*

(b) Lives in the east; eyes reach the jaws. *Vespa communis.*

(c) Lives in the east; eyes do not reach the jaws. *Vespa diabolica.*

B. *Tarantula hawks.* Genus *Pepsis.* Family Psammocharidae. South and west only. Huge wasps with satiny blue bodies, and usually orange colored antennae, very common in the west. Antennae curled in females, straight in males. Several species have orange wings, of which the commonest is *Pepsis formosa.* In Arizona one with steel-blue white-tipped wings and blue feelers is *Pepsis ornata.* The only

eastern species is common in the south, blue-black all over, including wings, but with orange feelers. It is *Pepsis elegans.*

C. *Mud-daubers.* Common everywhere. Build nests of mud on walls. Family Sphecidae. Three kinds as follows:

Fig. 111—*Mud-dauber, Sceliphron coementarium*

(*a*) Color steel-blue; wings blue. *Chalybion coeruleum.*

(*b*) Color black or brown with yellow spots and legs. *Sceliphron coementarium.*

(*c*) All shining black except half of the hind legs are white. Less common than the others. Eastern States, mostly in the South. *Trypoxylon albitarse.*

D. *Road-wasps.* Very long and slender, the abdomen attached to thorax by a *very* long thin stalk. Black, with partly red abdomen and legs, usually silvery sheen on sides of thorax. If stalk of abdomen is longer and made of two segments, the genus is *Sphex,* of which there are many species, common everywhere. Less common is *Psammophila,* with only one segment to the much shorter stalk. An all black western species is *Psammophila violacea.* Family Sphecidae.

E. *Sand-wasps and horse-guards.* Rather common everywhere. Family Sphecidae; tribe Bembicini.

(*a*) Horse-guard, catches horse-flies around horses. Very large black wasps striped with yellow. Southeast. *Stictia carolina.*

(*b*) Many other kinds, can be named only by use of technical characters.

Fig. 112—*Female Pelecinus*

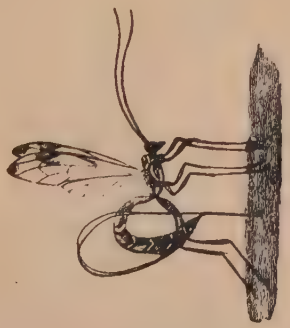


Fig. 113—*Megarhyssa lunator laying eggs in a tree*

F. *Other wasps, ichneumon-wasps.*

(*a*) Over two inches long, shiny black all over, abdomen a thin jointed tube, three times as long as a wing. Family Pelecinidae. ***Pelecinus polyturator.***

(*b*) Over two inches long, and with a long thread-like tail (ovipositor) which may be four to six inches long. Fly about dead trees and bore into the wood with this long tail. Males don't have the borer. Family Ichneumonidae. Genus ***Megarhyssa*** (called also ***Thalessa***).

(1) Females black with yellow head, and dark smoky wings; males dark brown with clear wings. Eastern. ***Megarhyssa atrata.***

(2) Brown, wings clear, but with dark patches. Eastern. ***Megarhyssa lunator.***

(3) Pale brown, with clear wings; females with round yellow spots on sides of abdomen. Western. ***Megarhyssa nortoni.***

(*c*) Ovipositor (the thread-like tail) curled up along the back of the abdomen, wings without noticeable veins; wings folded lengthwise when at rest; small and brown with yellow markings. On flowers. Family Chalcididae; genus ***Leucospis.***

G. *Velvet-ants or cow-killers.* Family Mutillidae. See under Requirement No. I:1 (d), pages 16 and 17.

(*a*) East of Rockies, Mississippi, also in Texas. 1½ inches long. Winged, top of head, thorax, and end half of abdomen covered with thick red or yellow hair. Males of ***Dasymutilla occidentalis.***

(*b*) East of Mississippi and in Texas. Wingless; 1½ inches long, head, thorax and abdomen covered with red hair, like velvet, but base of abdomen and band across its middle black. Females of ***Dasymutilla occidentalis.***

(*c*) Deserts of southwest. Covered all over with long white hair; looks like seed-pods of creosote-bush. ***Dasymutilla gloriosa.***

5. Roaches. Family Blattidae; order Orthoptera. Roaches liv-

Fig. 114—*A cockroach, Blatta orientalis, and its egg-case. a, female; b, male*

ing in the country and woods are difficult to name. The following live in houses and can be easily recognized:

(*a*) Half an inch long; pale brown, two brown stripes on top of thorax; wings reaching beyond tip of abdomen. Croton bug. *Blattella germanica.*

Fig. 115—*Periplaneta americana*

(*b*) Seven-eighths inches long; dark brown all over; wings not reaching to tip of abdomen, often very short. "Black beetle" or Oriental roach. *Blatta orientalis.*

(*c*) One and one-half inches long; dark brown, the thorax above yellowish, with a darker brown splotch on its center; wings reaching beyond tip of abdomen. Extreme south only, *Periplaneta americana.*

(*d*) Green roaches in bunches of bananas. *Panchlora.*

6. Praying-Mantids, Rear-Horses, Mule-Killers, Soothsayers. Family Mantidae; order Orthoptera.

Fig. 116—*A praying-mantis. Two-thirds natural size*

(*a*) In New York State only, *Mantis religiosa.* European mantis.

(*b*) Around Philadelphia only, *Tenodera sinensis.* Chinese mantis.

(*c*) Illinois, Indiana, and Eastern United States, south of Pennsylvania, (body two inches or more long, and stout; brown or green; common). *Stagmomantis carolina.* Carolina mantis.

(*d*) Three other kinds occur in the southeast, the chief of which is *Thesprotia graminis,* the grass-like mantis, which is very slender, almost stick-like, the head with a prominent triangular wart on top, on each side, next to the eyes. *Oligonyx scudderi,* Scudder's mantis, is also very long and slender, but the head has a cross-wise ridge on top. *Gonatista grisea,* the grizzled mantis, is short and stout, winged specimens only 1½ inches long.

7. Walking-Sticks. Never get wings. Family Phasmidae; order Orthoptera.

(*a*) Very long, (three to four inches) and slender, with very long legs, the first long segment of the hind legs with a strong curved spine beneath, near the tip. Very common all over the United States, east of the Rockies. Common walking-stick, *Diapheromera femorata.*

(*b*) Length two to three inches, but slender like the above. No spine on the hind legs. Uncommon. Blatchley's walking-stick, *Manomera blatchleyi.*

(*c*) Gigantic, 4½ to 6 inches long, thick-bodied. Louisiana chiefly, but also known from Alabama, Kentucky, Iowa, Mississippi, Missouri, Texas, and New Mexico. Rare. We wish any scout catching this would notify the author. Giant walking-stick, *Megaphasma dentricum.*

(*d*) Short and fat; 2 to 2½ inches long. Spray an ill-smelling liquid which will irritate one's eyes should it get into them. Southeastern States. Musk-mares. *Anisomorpha.*

(1) Found in Florida and along Atlantic and Gulf coastal region from South Carolina to Mississippi. *Anisomorpha buprestoides.*

(2) Found from the Alleghany Mountains westward to Nebraska, and from the Ohio River southward to the Gulf States. Smaller than the foregoing. *Anisomorpha ferruginea.*

Fig. 117—*A walking-stick, Diapheromera femorata. One-half natural size*

8. Grasshoppers. Feelers about as long as the thorax, or a little more, not *very* slender. Family Locustidae; order Orthoptera.

(*a*) Lubber-grasshoppers. Gulf Coast west to Louisiana. Two to three inches long, very fat, and wings only half as long as abdomen. Dull yellowish with red and black markings and red under wings. *Romalea microptera.*

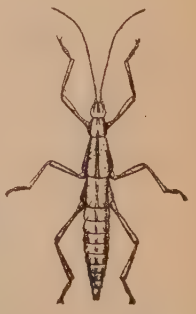


Fig. 118—***A musk-mare, Anisomorpha ferruginea. One-half natural size***

(*b*) Lubber-grasshoppers. Same region. Like above, but black with red markings. *Romalea microptera* variety

marsi. The young of the above live in clusters, and are black with a red line down their back, and legs and head more or less red.

(*c*) Lubber-grasshoppers. Southwestern States. Almost wingless. *Brachypeplus magnus.*

(*d*) Occurring in great swarms, destroying everything; in the Mississippi Valley; rarely farther east. Rocky Mountain Locust. *Melanoplus spretus.*

(*e*) Very abundant grasshopper in fields and pastures all over the United States, the most abundant kind anywhere except in the high land between the Mississippi and the Rockies. Known by its *red hind legs.* Red-legged locust. *Melanoplus femur-rubrum.*

Fig. 119—*Red-legged locust. Melanoplus femur-rubrum*

Fig. 120 — *The forked-tailed bush-katydid, Scudderia furcata A little less than natural size*

9. Katydids, Long-Horned Grasshoppers. Feelers very long and threadlike. Insects usually green in color. Family Tettigoniidae; order Orthoptera.

A. *Head rounded on top, without a sharp peg-like prominence; no spine between the front legs;* the blade (ovipositer) at tip of female's abdomen, short and curved.

(*a*) Ring-like segment at base of front legs with one spine beneath. Bush-katydids, *Scudderia.*

(*b*) Ring-like segment at base of all legs with several spines beneath, or top edge of forewings angled.

Fig. 121—*Oblong-winged katydid, Amblycorypha oblongifolia. Female, natural size*

(1) Second long segment of front legs flat or grooved above; upper edge of forewings uniformly rounded. Round-headed bush-katydids, *Amblycorypha*.

(2) Second long segment of front legs smooth and rounded out above; upper edge of forewings angled. Angle-winged katydids, *Microcentrum* (see Fig. 70).

Fig. 122—*A cone-headed grasshopper, Neoconocephalus exiliscanorus. Female, three-quarters natural size*

B. *Head with a sharp peg-like prominence on top, pointing forwards;* the blade (ovipositor) at tip of female's abdomen long and sharp. Cone-headed grasshoppers, *Neoconocephalus*.

C. *Top of head sometimes with a wart, or tubercle, but never with a sharp cone or peg; a tooth or two spines under the thorax between the front legs.*

Fig. 123—*A meadow-grasshopper, Orchelimum concinnum. Female; natural size*

(1) Spines under the thorax between the front legs rather long; the blade (ovipositor) of the female upcurved; wings not shorter than abdomen. The larger meadow-grasshoppers, *Orchelimum*.

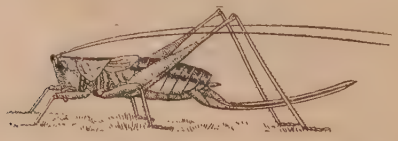


Fig. 124—*The wingless prairie-grasshopper, Conocephalus saltans. Female; One and one-half times natural size*

(2) Spines under the thorax very short or absent; the ovipositor nearly straight; wings usually shorter than the abdomen. The meadow-grasshoppers, *Conocephalus.* (See Figs. 69 and 124).

10. Sand-Crickets or "Potato-Bugs," as the name is used in California. Two or more inches long, wingless, with very large heads and powerful jaws, and long, thread-like feelers; pale yellowish-brown color; claws without little pads between

Fig. 125—*Stenopelmatus, "potato-bug"*

them. Slow-moving, clumsy creatures, do not jump; found under stones, boards, etc. and often eat potatoes. Pacific coast only. *Stenopelmatus;* family Tettigoniidae.

11. Mole-Crickets. Common in the south. Family Gryllidae; order Orthoptera. Velvety-brown, with short burrowing front legs, and short fan-like wings. *Gryllotalpa.* The

Fig. 126—*A mole-cricket, the "changa," Scapteriscus vicinus*

mole-crickets that injure crops in South Georgia and Florida are the "changa," *Scapteriscus.*

12. Crickets. Under stones, all over the United States. Family Gryllidae.

(*a*) Small black species, the body under ½ inch long. Ground-crickets. *Nemobius.*

(*b*) The winged individuals one inch or more long (excluding legs) black, or in the desert region, straw-colored.

Common under street-lights. House or field-cricket. *Gryllus assimilis.*

Fig. 127 — *Field-cricket, Gryllus assimilis. Female*

Male

Female

Fig. 128 — *Tree-crickets, Oecanthus Slightly less than natural size*

13. Tree-Crickets. Snowy white, with black markings. Very common on trees and plants. *Oecanthus;* family Gryllidae.

14. Damsel-flies. See under Requirement No. 1:9 (c), pages 86 to 89. Suborder Zygoptera; order Odonata.

A. *Body metallic green, or at least with a metallic green lustre.* Family Agrionidae.

(*a*) Body metallic green, wings all black, in the female each with a white spot. *Very* common along woodland streams from Maine to Florida and Texas, also in California. *Agrion maculatum;* called also *Calopteryx maculata.*

(*b*) Body metallic green, tips of all wings *black* in male, the entire wings smoky in female. Eastern United States. *Agrion apicale.*

(*c*) Body with metallic greenish lustre, not so strongly as in the above. Wings clear with rosy spots or streaks at the base. (The female of some lack the rosy spots); several kinds of these:

(1) Base of front wings of male crimson, of hind wings brown. Eastern States only. *Hetaerina tricolor.*

(2) Base of all four wings crimson in male. All over United States. *Hetaerina americana.*

(3) Other kinds occur in the extreme south.

B. *Body not metallic green; either blue, brown or red. Argia* and *Lestes;* family Coenagrionidae.

15. Dragon-flies. For distinction from damsel-flies see under Requirement No. 1:9 (c), page 87. Suborder Anisoptera; order Odonata.

(*a*) Very common everywhere in United States, except southwest, resting on logs or fences, or flying around still ponds and ditches. Body broad; blue covered with a white bloom, like a blue plum; wings somewhat milky, with a black patch at base, and a broad brownish-black

Fig. 129—*The white-tail, Plathemis lydia*

stripe clear across the middle of each. May also be told by its position, holding wings slanting forward and downward when at rest. Wings when open measuring four inches from tip to tip. Males of the white-tail, *Plathemis lydia;* family Libellulidae.

(*b*) Females of the above differ in having three black blotches on each wing, one occupying the tip, and in having the body brown with yellow spots on it. (The young males have their body also colored this way).

Fig. 130—*Libellula pulchella*

(*c*) Common all over Eastern United States, around ponds. Both sexes with three black blotches on each wing, as in

the female of the white-tail, and old specimens with body blue and white-powdered as in that species, but carry wings differently when at rest. The wings of the male are whiter than those of the female. Wings 3 to 3½ inches in expansion. *Libellula pulchella;* family Libellulidae.

(*d*) Pacific Coast and Western States. Brilliant crimson-red body and wings, or largely reddish orange. *Libellula saturata;* family Libellulidae.

(*e*) Very small species (wings when spread 1½ inches from tip to tip) amber-colored wings, the female with large brown blotches on them, the males uniform amber. Very common, resting on stems and grasses about ponds, throughout the eastern United States, especially southward. The amber-wing, *Perithemis domitia;* family Libellulidae.

Fig. 131—*Dobson-fly, Corydalis cornuta*

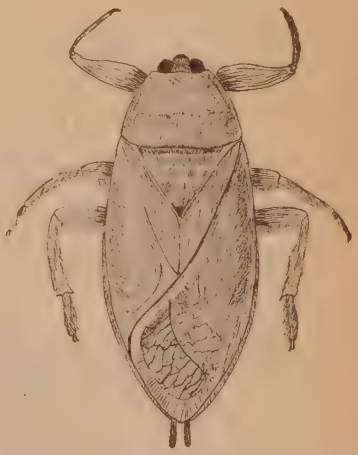


Fig. 132—*A giant water-bug, Benacus griseus*

16. Dobson-flies, or Hellgramites. Family Sialidae; order Neuroptera. The adult is as large as a tomato-sphinx moth, but has translucent brownish, speckled, wings, and long,

stiff, feelers. Hind corners of the head sharply angled. They often sit about under arc-lights in towns. The male, unlike the female, has a pair of huge pincers for jaws, which cross each other like an X and are ¾ of an inch long. *Corydalis cornuta.* Some species of *Chauliodes* resemble female dobsons, but have the hind corners of the head *rounded* and often have the feelers feather-like.

17. True Bugs. Mouth a sucking beak; wing-covers with basal half or two-thirds leathery, the end membranous. Order Hemiptera.

A. *Electric-light bugs, or giant water-bugs.* Family Belostomidae; order Hemiptera. Great big creatures, two or three inches long, and with front legs held out like claws, ready to grasp anything. Common under arc-lights, coming from ponds, where they live hidden in weeds under water. Two kinds.

(*a*) Front margin of basal segment of front leg with a groove running the whole length of it, into which the next segment can be fitted. *Lethocerus americanus.* In Florida the more common species, looking just the same is *Lethocerus uhleri.*

(*b*) Segment of leg rounded, not grooved. East of Mississippi River. *Benacus griseus.*

B. *Toad-bugs.* Family Gelastocoridae. Order Hemiptera. Common about sandy shores and mud-flats in southern States and California. May be recognized by their broad, rounded body, prominent pop-eyes and hopping gait. Speckled brown or grey.

(*a*) Eastern States, south of New York. *Gelastocoris oculatus.*

(*b*) Pacific Coast and southwest. *Gelastoris variegatus.*

Fig. 133—*A water-boatman*

C. *Water-boatmen.* Swim back-side up; back nearly flat. All over United States. *Arctocorixa;* family Corixidae.

D. *Back-swimmers.* Swim belly-side up; back strongly convex, like the bottom of a row boat. See under Requirement No. 1:6 (a), pages 56 to 58.

E. *Water-striders.* See under Requirement No. 1:6 (c), pages 60 and 61.

(*a*) Middle and hind legs very long, close together, arising far from front pair. True water-striders; family Gerridae.

(1) Body long, over four times as long as broad. *Gerris.*

(*b*) Middle and hind legs not especially long, not much closer together than to front legs. Broad-shouldered water-striders. Family Veliidae.

F. *Wheel-bug.* Family Reduviidae; order Hemiptera. Frequent in the southeast. Has a back like a cog-wheel; a grey bug, about 1½ inches long. *Arilus cristatus.*

G. *Big bed-bug, Chinese bed-bug.* Family Reduviidae. Southeast. One inch long; black, marked with red; has a stinging beak. Often about houses, where it feeds on bed-bugs, and sometimes human blood, giving a severe and long-lasting bite. *Triatoma sanguisuga.*

Fig. 134—*Big bed-bug, Triatoma sanguisuga*

Fig. 135—*A leaf-footed bug, Metapodius femoratus*

H. *Leaf-footed bugs.* Hind legs expanded like a leaf. Common in the east,. especially southward.

(*a*) Back of thorax rough; very large. *Metapodius femoratus;* family Coreidae.

(*b*) Back of thorax smooth; medium size; with a pale stripe across the middle of its back. *Leptoglossus phyllopus;* family Coreidae.

(*c*) Back of thorax smooth; medium size; no pale stripe. *Leptoglossus oppositus.*

Fig. 136—*A leaf-footed bug, Leptoglossus oppositus*

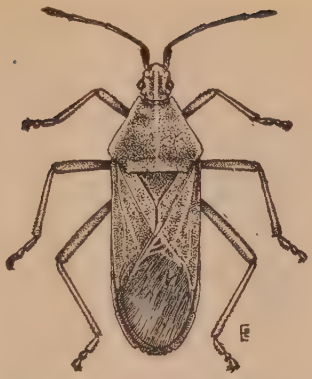


Fig. 137—*The common squash-bug, Anasa tristis. Enlarged*

I. *Squash-bugs.* Family Coreidae. See Requirement No. 1:12 (a), on pages 101 and 102.

(*a*) Head without horns. Common all over the United States. Squash-bug, *Anasa tristis.*

(*b*) Head with two horns behind the antennae. Missouri to Maryland and southward, occurs with the common squash-bug. Horned squash-bug, *Anasa armigera.*

Fig. 138—*The horned squash-bug, Anasa armigera. Enlarged*

Fig. 139—*The bed-bug, Cimex lectularius. Enlarged*

J. *Bed-bug. Cimex lectularius;* family Cimicidae.

K. *Stink-bugs.* Family Pentatomidae.

(*a*) Brilliant red and black. Very common in southern, central and western States. Harlequin cabbage-bug, terrapin-bug, or calico-back, *Murgantia histrionica.*

18. Cicadas or "Locusts;" only the males can sing, having a musical instrument under the abdomen. Family Cicadidae; order Homoptera.

Fig. 140—*The seventeen-year locust, Tibicina septendecim*

(*a*) Seventeen-year locust, marked with red; occurs different seasons in great swarms in eastern United States. *Tibicina septendecim.*

(*b*) The large greenish locusts of the eastern States are *Tibicen.*

19. Beetles. Order Coleoptera.

A. *Tiger-beetles.* See Requirement No. 1:10 (e), page 93. Cicindela.

(*a*) A very common eastern kind is metallic green, usually with six little buff spots on the wing-covers. *Cicindela sexguttata.*

(*b*) Along the Atlantic sea-coast on the white sand, a white species, with curved brown lines on its wing-covers. *Cicindela dorsalis.*

B. *Ground-beetles.* Family Carabidae; order Coleoptera.

(*a*) A large metallic green beetle, with ridged wing-covers, and coppery borders; 1½ inches long. Not uncommon; occurs all over the United States. *Runs about over the ground*, and is sometimes found under arc-lights. Green caterpillar-hunter. *Calosoma scrutator.*

(*b*) Similar, but ¾ inch long. *Calosoma willcoxi.*

(*c*) Other common species, found mostly under arc-lights, where they are often very common, black in color, shaped like the above, are known by having their backs set with what look like rows of emeralds or rubies.

(1) Gems on back green. Northeast only, north of New York, *Calosoma frigidum.*

(2) Gems on back green. Southeast only, *Calosoma sayi.*

(3) Gems on back red. Everywhere. *Calosoma calidum.*

Fig. 141—*Calosoma calidum*

(*d*) Others common in southwest and California are shaped like above, but all black and smooth, without jewels on back. Look like pinacate beetles, but *run fast. Calosoma.*

(*e*) Bombardier-beetles. Common, under stones, everywhere. Blue beetles with red head, thorax, and legs. Run swiftly when disturbed and *shoot out a puff of smoke* with a sharp little report. *Brachynus.*

(*f*) Larger blue beetles, with red thorax, head and legs, also under stones, run swiftly, but *do not shoot*. Very common in the eastern States. *Galerita janus.*

C. *Lady-beetles.* Family Coccinellidae. For distinctions from leaf-beetles see under Requirement No. 1:7 (c), page 61.

(*a*) Small, orange-colored with two black spots on wing-covers, very common all over the United States. Enters houses in fall and often found on window panes. Two-spotted lady-beetle. *Adalia bipunctata.*

(*b*) Larger, orange-colored with nine spots on the wing-covers. All over the United States. Nine-spotted lady-beetle. *Coccinella novemnotata.*

(*c*) More slender, pinkish-red, with ten black spots. *Ceratomegilla fuscilabris.*

Fig. 142.—*A lady-beetle, Ceratomegilla fuscilabris.*

D. *Carrion-beetles.* See Requirement No. 1:7 (a), page 61, for habits of Silpha and Necrophorus.

(*a*) Necrophorus. Not flattened; elongate; thorax narrowed behind.

(1) Bow-legged (hind legs); large (1 to 1½ inches long); head and thorax orange above, and four orange spots on wing-covers. Feeds on dead lizards and snakes. Eastern States, especially in the south. *Necrophorus americana.*

(2) Bow-legged, under inch long; no orange on head or thorax; wing-covers with four separate cross-wise patches of orange. Scarce. Northeast. *Necrophorus sayi.*

(3) Bow-legged, under inch long; no orange on head or thorax. An orange cross-bar extending across both wing-covers in front, and a cross-bar across each behind; the two latter almost joining each other. Northeast, California, and Arizona. *Necrophorus marginatus.*

(4) Bow-legged, black, except for six orange spots, four near base, and two near tip of wing-covers. Gulf States. *Necrophorus carolinus.*

(5) Straight hind legs. Black with four orange cross-blotches on wing-covers. Eastern States. *Necrophorus orbicollis.*

(6) All black; legs bowed; California and Rocky Mountain States. *Necrophorus guttula.*

(7) All black; legs straight; California. *Necrophorus pustulatus*, variety *nigritus.*

(8) Black, except for six orange spots near the tip of the wing-covers. East of Rocky Mountains. *Necrophorus pustulatus.*

(9) Thorax covered on top with short yellow hair; wing-covers with four orange bars. Eastern States. *Necrophorus tomentosus.*

(*b*) Silpha and its allies. Much flattened; oval (except one species); thorax broadened behind.

(1) Very smooth and dull satiny black. Southwest. *Philas truncata.*

(2) Long; black with a row of orange spots or a bar before tip of each wing-cover; wing-covers ridged. Eastern States. *Silpha surinamensis.*

(3) Oval; all black. East of Rockies. See Fig. 33. *Silpha inaequalis.*

(4) Oval; black, except orange border of tip of thorax; wing-covers with some ridges running lengthwise. East of Rockies. *Silpha noveboracensis.*

(5) Oval; brownish-black, but thorax above yellow, with a brown central splotch; wing-covers crinkly. Eastern United States. *Silpha americana.*

(6) Oval; all black; wing-covers crinkly. Western States. *Silpha ramosa.*

Fig. 143—*Silpha americana*

(7) Oval; small; brown; wing-covers with many close ridges. Pacific Coast. *Necrophilus hydrophiloides.*

(8) Oval; all black, but head and thorax appearing yellow above because covered with short yellow hair. *Silpha lapponica.*

E. *Carpet-beetles.* Family Dermestidae. It is the little whitish larvae, all covered with brown tufts of hair that eat the carpets, woolens, furs, etc., and that get into a collection of insects and reduce the specimens to dust. Keep them shut up in a box with plenty of dead, dry, insects to feed on, and by and by they will transform to adults. Very tiny round convex beetles.

(*a*) Color red-and-white mottled. Buffalo carpet-beetle. *Anthrenus scrophulariae.*

(*b*) Color black. Black carpet-beetle. *Attagenus piceus.*

Fig. 144—*Buffalo carpet-beetle. Six times natural size*

F. *Sap-beetles.* *Glischrochilus* [Ips.] At the sap of freshly cut stumps in early spring; small black beetles with four yellow or reddish-yellow spots, or wing-covers red with black spots. Family Nitidulidae.

(*a*) Wing-covers black with four yellow spots. Under one-third inch long. *Glischrochilus fasciatus.*

(*b*) Wing-covers black with four reddish-yellow spots. Over one-third inch long. *Glischrochilus obtusus.*

(*c*) Wing-covers red, except their tips and four black spots. *Glischrochilus sanguinolentus.*

G. *Click-beetles.* Family Elateridae.

(*a*) Very large pepper-and-salt colored species, one and one-half inches long; with two large velvety spots on the thorax, each bordered with a white line, and looking like huge eyes. *Alaus.*

(*b*) Large click-beetles, which have two spots on prothorax that shine brightly at night, like a fire-fly, as the beetle flies around. Extreme south and southwest only. *Pyrophorus.*

Fig. 145—*The eyed elater; Alaus oculatus*

Fig. 146—*A May-beetle; Phyllophaga*

Fig. 147—*The June-beetle; Pellidnota punctata*

H. *May-beetles, etc.* Family Scarabaeidae.

(*a*) The big brown beetles that buzz about a lighted room on summer evenings, whose legs stick and cling tight when they get hold of your finger. May-beetles. *Phyllophaga.*

(*b*) Large velvety-green beetles, very common southward, especially on figs. Southern June-beetle, fig-eater. *Cotinus* [*Allorhina*]. The eastern species is *Cotinus nitida.*

(*c*) Large yellowish-brown, clumsy beetles, with eight small dark spots around their sides. Common on grape in eastern States. At night flies to lights. *Pellidnota punctata.*

I. *Rose-chafers.* Abundant east of Rockies, on roses. *Macrodactylus subspinosus;* family Scarabaeidae.

Fig. 148 — *Rose-chafers, Macrodactylus subspinosus*

J. *Hercules and ox-beetles.* Family Scarabaeidae.

(*a*) Hercules beetles. Huge greenish beetles with two great horns in front, meeting like a pair of pincers. These horns are hairy beneath and there are two smaller horns on each side. The females are as large, but brown and without horns. Found only in the south. Common under arc-lights. *Dynastes tityus.*

(*b*) Large cherry red-beetles with three great erect horns on the thorax. Southern States; mostly found under street-lights. Males of ox-beetle, *Strategus anteus.* The female looks similar, except that it has only one short horn placed in the middle of the front of the thorax.

Fig. 149—*The Hercules beetle, Dynastes tityus. Male; three-quarter times natural size*

K. *Stag-beetles.* Large (over one inch long); reddish-brown, somewhat shiny beetles with very large pincer-like jaws. Frequently found except in the northeast, under street-lights. Females all have short mandibles. *Lucanus;* family Lucanidae.

(*a*) Mandibles as long as the abdomen. Rare. Southern States. Males of *Lucanus elephas.*

(*b*) Mandibles only as long as thorax. South and east, north to New York. Common. *Lucanus dama.* Mississippi valley, several teeth on inside of jaws of male. *Lucanus placidus.*

Fig. 150 — *A stag-beetle, Lucanus elephas. Male*

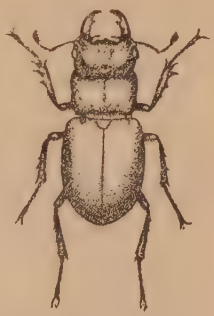


Fig. 151 — *A stag-beetle, Lucanus dama. Male*

L. *Tumble-bugs and dung-beetles.* Family Scarabaeidae. See Requirement No. 1:7 (b), page 63.

(*a*) Smooth, that is without ridges; with a velvety lustre; dull green; wing-covers not reaching tip of abdomen; no horns. Commonest tumble-bugs in the south. *Canthon.*

(*b*) Brilliant metallic green, with coppery-red thorax; the male with a long curved horn. Large, stout beetles. *Phanaeus carnifex.*

(*c*) Plain black; an inch long, and very stout, with seven strong ridges on each wing-cover; male with a short horn. Southeast. *Copris carolina.*

(*d*) Small beetles, one-third inch long; more slender; head and thorax shiny black; wing-covers brick-red. Very abundant in cow-dung in the east and south. *Aphodius fimetarius.*

M. *Long-horned beetles.* Family Cerambycide.

(*a*) On milkweed in late summer and fall. A red beetle, about one-half inch long, with six or more black spots and long feelers. Squeak when picked up. *Tetraopes.* The common northeastern one is *Tetraops tetrophthalmus.*

Fig. 152—*The locust-borer, Cyllene robiniae*

(*b*) On goldenrod. Black or greenish with golden cross stripes and W-shaped marks, red legs and long feelers; very pretty. Locust-borer. *Cyllene robiniae.*

(*c*) Large blue beetle with broad yellow band across its middle third. Common in the east on elder-bushes. Cloaked knotty-horn. *Desmocerus palliatus.*

(*d*) Large beetles, one inch or more long; speckled grey and brown; the antennae very long, sometimes nearly five inches. *Monohammus.*

N. *Pinacate beetles.* Under stones and boards in the West. Big black beetles, which stick their tail up in the air as though trying to stand on their head when disturbed. *Eleodes;* family Tenebrionidae.

Fig. 153 — *A pinacate beetle, Eleodes*

APPENDIX B

LIST OF ORDERS AND FAMILIES OF INSECTS FOUND IN THE UNITED STATES

This list is for reference, as you would use a dictionary, and no scout is expected to learn it. Use it in arranging your collection of insects.

The orders and families more commonly collected are set in **bold faced type,** the very large and common orders and families in BOLD-FACE SMALL CAPITALS. Those in ordinary roman type are the smaller, less common groups, while those in *italics* contain very few, or very small or very rare insects, which the beginner is not likely to collect, nor if he collects to identify.

Unfortunately all writers are not agreed as to how many families of insects there are, some dividing certain of the families of this list into several, others uniting some of them into one. So, too, some authors use one name, others another, for identical families. We have adopted what we believe to be the most satisfactory classification available, and the zoologically correct names. In order that the scout may not be unduly puzzled in seeing how this list corresponds to other works, we have sometimes added synonymous family and ordinal names in square brackets; and in the same way have indicated when a particular family is included by some authors as part of another.

The authors wish to express particular thanks to Professor J. H. Comstock for information which has enabled them in a large measure to adopt the names and classification which will be used in his forthcoming "Introduction to Entomology," which will undoubtedly be the standard text book upon insects for years to come.

PRONUNCIATION

The symbols used to indicate the pronunciation of words are those employed by the Standard Dictionary and called in it "Key 1," and are as given below. The syllable which has the principal stress, is marked by an acute accent (') after it. Syllables that have less stress than the primary, are marked with a secondary accent (").

ä as artistic
ā as art
a as at
e as get
ē as prey, face
ə as the man, cannon
i as bit
ī as police, eat
ɪ as habit, surfeit
o as polo
ō as go, no
ɔ as hot, what
ō as or, roar, all, ough
u as pull, wood
ū as ruse, mood
ʊ as nut, son
ʊ̄ as surf, sir, earl
ai as aisle, mine, try
au as pout, kraut, now
iu as supurate, duration
ū as impure, few, beau
ɔi as boil, Roy
t͡ch as chill
k as kill, car, ache
g as game
j as in jam
ŋ as lung, tank
t͡h as throw
s as sell, cell
z as buzz, has

Class ARACHNIDA

(ə-rak'ni-də). Spiders, scorpions and their allies.

For the orders and families, see The spider book, by J. H. Comstock. (Bibliography item 24, page 171)

Class INSECTA

(in-sek'-tə). Insects.

Order *Protura* (pro-tu'rə). Minute extremely rare insects; wingless.

Family *Eosentomidae* (ī"o-sen-tōm'ī-dī). Minute, delicate, white insects found under stones.

Order Thysanura (thai"sə-niū'rə). Bristle-tails. Small, inconspicuous, wingless.

Family. *Japygidae* (ja-pij'ī-dī). Minute, forceps at tail; under stones (not to be confounded with earwigs, order Dermaptera).

Fig. 154—A Silver-fish *Lepisma saccharina*.

Family Lepismatidae (lep"iz-mat'ī-dī). Silver-fish. Found about closets.

Family *Campodeidae* (kam"po-dī'ī-dī). Minute, slender, white insects found under stones.

Family *Machilidae* (mə-kīl'ī-dī). Small, covered with scales; leap; among dead leaves, or under stones.

Order *Collembola* (kə-lem'bo-lə) Spring-tails. All very minute, capable of leaping like a flea; wingless, not ordinarily noticed; live under stones, in fungus, in humus, or on surface of water. [By some authors united with Thysanura.]

Families: *Poduridae* (po-diū'rī-dī); *Entomobryidae* (en"to-mo-brai'ī-dī); *Sminthuridae* (smin-thiū'rī-dī).

Order **ORTHOPTERA** (ər-thəp′tər-ə).

Family **Blattidae** (blat′ɪ-dī). Roaches. In houses and woods.

Family Mantidae (man′tɪ-dī). Praying mantises, rear-horses. Southern.

Family Phasmidae (fas′mɪ-dī). Walking sticks.

Family **LOCUSTIDAE** (lo-kus′tɪ-dī). Short horned grasshoppers. [Acrididae; some authors include Tettigidae; the name Locustidae used to be applied to Tettigoniidae.]

Family Tettigidae (tə-tij′ɪ-dī) grouse-locusts. [Sometimes included in Locustidae.]

Family **TETTIGONIIDAE** (tet″ɪ-go-nī′ɪ-dī). Long horned grasshoppers, katydids, cave-crickets, California "potato-bugs." [Locustidae].

Family **Gryllidae** (gril′ɪ-dī). Crickets, tree-crickets, mole-crickets.

Order *Zoraptera* (zo-rap′tə-rə). Extremely rare, minute insects.

Family *Zorotypidae* (zō″ro-tip′ɪ-dī). Two kinds, on the Gulf Coast; resemble termites.

Order Isoptera (ai-sop′tə-rə). Termites or white ants.

Families Termitidae (tur-mit′ɪ-dī); *Kalotermitidae* (kal″o-tur-mit′ɪ-dī).

Order **Neuroptera** (niu-rop′tə-rə). Dobsons, lace-winged flies, ant-lions, and others. [Includes Megaloptera.]

Family Sialidae (sai-al′ɪ-dī). Dobsons or hellgramites, etc. [Includes Corydalidae.]

Family Raphidiidae (raf″ɪ-dī′ɪ-dī). Raphidians. Pacific coast only.

Family *Mantispidae* (man-tis′pɪ-dī). Mantis-like flies. Rare, southern and southwestern.

Family *Sisyridae* (si-sīr′ɪ-dī). Sisyra. An uncommon aquatic insect.

Family *Sympherobiidae* (sim″fə-rō-bī′ɪ-dī). Two kinds.

Family Hemerobiidae (hem″er-o-bī′ɪ-dī). Hemerobians.

Family *Dilaridae* (dɪ-lar′ɪ-dī). One very rare species.

Family *Berothidae* (bɪ-rō′thɪ-dī). Two species.

Family Polystoechotidae (pol″ɪ-stek-ō″tɪ-dī). Smoke-flies. Northern.

Family Chrysopidae (krɪ-sop′ɪ-dī). Lace-wing flies, or aphis-lions.

Family **Myrmeleonidae** (mɪr-mī″lɪ-on′ī-dī). Ant-lions (adults of doodle-bugs). Mostly southern; attracted to lights.

Family *Ascalaphidæ* (as″kə-laf′ɪ-dī). Ascalaphids. Large but very rare insects, resemble ant lions, but have long clubbed antennæ.

Family *Coniopterygidæ* (kon″ɪ-op-tər-ij′ɪ-dī). Very small; scarce.

Order **Ephemerida** (ef″ɪ-mer′ɪ-də) May-flies. [Plectoptera.]

Family **Ephemeridae** (ef″ɪ-mer′ɪ-dī).

Order **Odonata** (o″do-na′tə). Dragon-flies, snake-doctors, or darning needles.

Family Agrionidae (ag″rɪ-on′ɪ-dī). Ruby-spots and black-wings. [Calopterygidae, not Agrionidae of some authors.]

Family **Coenagrionidae** (sī″nag-rɪ-on′ɪ-dī). Damsel-flies [Agrionidae as used by most authors].

Family Aeshnidae (esh′nɪ-dī). Dragon-flies.
Family **Libellulidae** (lī″be-liū′lɪ-dī). Dragon-flies.

Order Plecoptera (pli-cəp′tə-rə). Stone-flies, young in water.
Families: Nemouridae (ne-mū′rɪ-dī); Capniidae (kap-nī′ɪ-dī); Perlidae (pɒr′lɪ-dī); Pteronarcidae (ter″o-nar′sɪ-dī).

Order *Corrodentia* (kər″o-den′shɪ-ə). Bark-lice and book-lice.
Family *Psocidae* (sos′ɪ-dī). Bark-lice. Minute insects on bark and under leaves.
Family *Atropidae* (at-rō′pɪ-dī). Book-lice. Minute white insects.

Order *Mallophaga* (ma-ləf′ə-gə). Bird-lice.
Families: *Trichodectidae* (trik″o-dek′tɪ-dī); *Philopteridae* (fil″əp-ter′ɪ-dī); *Gyropodidæ* (jai″ro-pō′dɪ-dī); *Liotheidae* (lai″o-thī′ɪ-dī).

Order *Thysanoptera* (thai″sən-əp′tə-rə). Thrips [Physopoda].
Families: *Aeolothripidæ* (ī″o-lo-thrip′ɪ-dī); *Thripidae* (thrip′ɪ-dī); *Phloeothripidae* (flī″o-thrip′ɪ-dī).

Order *Embiidina* (em-bī″ɪ-dī′nə). Very rare, small insects.
Family *Embiidae* (em-bī′ɪ-dī). Three rare kinds, extreme south and California.

Order Anoplura (an″o-plū′rə). True lice [Phytophthiria; by some authors included in Hemiptera].
Family Pediculidae (ped″ɪ-kiū′lɪ-dī). Head-lice, body-lice and crab-lice belong to this family.
Family *Haematopinidae* (hem″ət-ō-pī′nɪ-dī).
Family *Echinopthiriidæ* (ek-ɪn″o-thir-ī′ɪ-dī).

Order **HEMIPTERA** (hə-mip′tə-rə). True bugs. [By many authors united with Homoptera].
Family **Corixidae** (co-rix′ɪ-dī). Water-boatmen. Common in pools.

Fig. 155—The crab-louse, *Phthirius pubis*, greatly magnified.

Family *Ochteriidae* (ɔĸ″tə-rī′ɪ-dī).
Family Gelastocoridae (ge-las″to-ĸēr′ɪ-dī). Toad-bugs. On stream margins.
Family **Belostomidae** (bel″ɔs-təm′ɪ-dī). Giant water-bugs or electric-light bugs. In ponds and at arc lights.
Family Nepidae (nī′pɪ-dī). Water-scorpions; in ponds.
Family Naucorida (nē-cō′rɪ-dī). In ponds.
Family **Notonectidae** (nō″tə-nek′tɪ-dī). Back-swimmers. In pools and ponds.
Family Saldidae (sal′dɪ-dī). Shore-bugs. Shores of streams, fly readily.
Family Veliidae (və-lī′ɪ-dī). Broad-shouldered water-striders. On surface of water.
Family **Gerridae** (ger′ɪ-dī). Water-striders. On surface of water.
Family *Hydrometridae* (hai″dro-met′rɪ-dī). Marsh-treaders.
Family *Schizopteridae* (skiz″ep-ter′ɪ-dī). Very rare, small insects.
Family *Dipsocoridae* (dip″so-cō′rɪ-dī). Very rare, small insects.
Family *Isometopidae* (ai″so-me-tō′pɪ-dī). Very rare, small insects.
Family **MIRIDAE** (mir′ɪ-dī). Plant-bugs; very abundant; small.
Family *Termatophyllidae* (tūr-mat″ō-fai′lɪ-dī). Two rare kinds.
Family *Acanthocoridae* (a-kan thō-ĸē-rɪ-dī). Scarce and small bugs.
Family Cimicidae (sɪ-mis′ɪ-dī). Bed-bugs.
Family Nabidae (nab-ɪ-dī). Damsel-bugs. Common on grass.
Family *Mesoveliidae* (mes″ō-və-lī-ɪ′dī). Minute; on surface of water.
Family *Hebridae* (heb′rɪ-dī). Four small species; about water.
Family **Reduviidae** (red-yu-vī′ɪ-dī). Assassin-bugs.
Family Phymatidae (fai-mat′ɪ-dī). Ambush-bugs; on flowers.
Family *Enicocephalidae* (en″ɪ-kō-sə-fal′ɪ-dī). Very rare and minute; swarm like midges at sunset.
Family Tingitidae (tin-jit′ɪ-dī). Lace-wing bugs. On leaves. [Tingidae, Tingididae]
Family Pyrrhocoridae (pir″o-kē′rɪ-dī).
Family **LYGAEIDAE** (lai-jī-ɪ-dī). The chinch-bug family. Common about plants or on the ground.
Family Neididae (nē-ɪd-ɪ-dī). Stilt-bugs. One or two kinds are common on grasses.
Family Aradidae (ə-rad′ɪ-dī). Flat-bugs. Under bark.
Family **COREIDAE** (ko-rī-ɪ′dī). The squash-bug family.
Family **PENTATOMIDAE** (pen″tə-təm′ɪ-dī). Stink-bugs. Common on plants.
Family Cydnidae (sid′nɪ-dī). Burrower-bugs and Negro-bugs. Common under arc lights and on the ground. [Includes Corimelaenidæ].
Family Scutelleridae (skɪū″te-ler′ɪ-dī). Shield-backed bugs. On plants.

Order **HOMOPTERA** (ho-mɔp′tə-rə). Scales, plant-lice, hoppers, cicadas. [Included often in Hemiptera].
Family **Cicadidae** (sɪ-kad′ɪ-dī). Cicadas, "locusts." Common, singing on trees.

Family Cercopidae (sûr-kēp'ĭ-dī). Spittle-bugs or frog-hoppers. Common on plants.
Family **Membracidae** (mem-bras'ĭ-dī). Tree-hoppers. Common on trees and grasses.
Family **CICADELLIDAE** (sik″ə-del'ĭ-dī). Leaf-hoppers. Very many kinds, on leaves. [Jassidæ].
Family **Fulgoridae** (fûl-gōr'ĭ-dī). The lantern-fly family. Common on plants.
Family Chermidae (kûr'mĭ-dī). Jumping plant-lice, or psyllids. [Psyllidae].
Family **APHIDIDAE** (a-fid'ĭ-dī). Plant-lice or aphids.
Family *Aleyrodidae* (al″ĭ-rəd'ĭ-dī). White-flies. [Aleurodidae]
Family **COCCIDAE** (kək'sĭ-dī). Scale-insects, bark-lice, or coccids.

Order Dermaptera (dûr-map'tə-rə). Ear-wigs. [Euplexoptera]. [Sometimes included in Orthoptera].
Families Labiduridae (lab″ĭ-diu'rĭ-dī); Labiidæ (la-bī'ĭ-dī) and Forficulidae (fōr″fĭ-kiū'lĭ-dī). *Chelisochidae* (kī″lĭ-sō'kĭ-dī), 1 species, California, introduced.

Order **COLEOPTERA** (kel″ĭ-əp'tə-rə). Beetles.
Family **Cicindelidae** (sis″ĭn-del'ĭ-dī). Tiger-beetles. Common; brightly colored.
Family **CARABIDAE** (kə-rab'ĭ-dī). Ground-beetles. Numerous; very many kinds, mostly under stones, or attracted to lights. [Often includes Omophronidae].
Family *Amphizoidae* (am-fi-zō'ĭ-dī). Very rare, in streams; Pacific coast only.
Family *Omophronidae* (əm″o-frən'ĭ-dī). Scarce, on stream banks. [Often in Carabidae].
Family Haliplidae (hə-lip'lĭ-dī). Haliplids. In water. Common, small.
Family **Dytiscidae** (dai-tis'ĭ-dī). Predaceous diving-beetles; larvae called water-tigers. Very common under water, or attracted to lights.
Family **Gyrinidae** (jai-rin'ĭ-dī). Whirligig-beetles. Common on surface of water.
Family **Hydrophilidae** (hai″dro-fil'ĭ-dī). Water-scavengers. Common in pools and ponds.
Family *Platypsyllidae* (plat″ĭ-sil'ĭ-dī). Beaver-parasites. In the fur of beavers. 1 kind.
Family *Brathinidae* (bra-thin'ĭ-dī). 3 kinds.
Family *Leptinidae* (lep-tin'ĭ-dī). Four kinds.
Family **Silphidae** (sil'fĭ-dī). Carrion-beetles. Common on carrion.
Family *Clambidae* (clam'bĭ-dī). Six kinds. [Often included in Silphidae].
Family *Scydmaenidae* (skid-mī'nĭ-dī). Minute beetles, under stones, in ants' nests, etc.
Family *Corylophidae* (kə̄″rĭ-lō'fĭ-dī). Few. [Orthoperidae].
Family **STAPHYLINIDAE** (staf″ĭ-lin'ĭ-dī). Rove-beetles. Very common in dung, carrion or toadstools, under stones or bark and on stream-margins.
Family *Pselaphidae* (sə-laf'ĭ-dī). Minute beetles, under stones or in ants' nests.

Family *Clavigeridae* (klav″ɪ-jer′ɪ-dī). Nine kinds, minute. [Often in Pselaphidae].

Family *Trichopterygidae* (trai-kŏp″tə-rij′ɪ-dī). Feather-wing beetles. The smallest beetles known; under bark. [Ptiliidae].

Family *Scaphidiidae* (skaf″ɪ-dī′ɪ-dī). Small beetles in fungi and rotten wood.

Family *Sphaeritidae* (sfai-rit′ɪ-dī). One kind; California.

Family *Sphaeriidæ* (sfai-rī′ɪ-dī). Three kinds.

Family Histeridae (his-ter′ɪ-dī). Small black beetles under bark or in carrion.

Family **Lycidae** (lai′sɪ-dī). False fire-flies, common. [Often included in Lampyridae].

Family **Lampyridae** (lam-pī′rɪ-dī). Fire-flies. [Often includes Lycidae, Phengodidae and Cantharidae].

Family *Phengodidae* (fen-gō′dɪ-dī). Certain rare glow-worms. [Often in Lampyridae].

Family **CANTHARIDAE** (kan-thăr′ɪ-dī). Soldier-beetles. Very common on leaves and plants. [Often included in Lampyridae; Telephoridae].

Family Melyridae (mə-lir′ɪ-dī). [Malachidae].

Family Cleridae (kler′ɪ-dī). Checkered-beetles. Brightly colored beetles running over tree-trunks. [Often includes Corynetidae].

Family *Corynetidae* (kŏr″ɪ-net′-ɪ-dī). [Often included in Cleridae].

Family *Othniidae* (ŏth-nī′ɪ-dī). Four kinds.

Family *Lymexyllidae* (lim″ə-xil′ɪ-dī). Two kinds.

Family *Micromalthidae* (mai″kro-mal′thɪ-dī). One kind.

Family *Cupesidae* (kiū-pes′ɪ-dī). Four kinds.

Family *Cephaloidae* (sef″ə-lō′ɪ-dī). Seven kinds.

Family Oedemeridae (ī″dɪ-mer′ɪ-dī). On plants, few kinds.

Family Mordellidae (mŏr-del′ɪ-dī). Common on flowers. Small beetles pointed behind.

Family Ripiphoridae (rip″ɪ-fŏr′ɪ-dī). Feather-horn beetles. Scarce small beetles.

Family **Meloidae** (mɪ-lō′ɪ-dī). Blister-beetles. Very common on plants.

Family *Eurystethidae* (yu″rɪ-steth′ɪ-dī). Two rare kinds, below high tide marks on Pacific coast. [Aegialitidae].

Family Pythidae (pai′thɪ-dī). Sixteen kinds.

Family Pyrochroidae (pir″o-krō′ɪ-dī). Ten kinds.

Family Pedilidae (pə-dil′ɪ-dī). Small beetles. [Often in Anthicidae].

Family Anthicidae (an-this′ɪ-dī). Small beetles. [Often includes Pedilidae].

Family *Euglenidae* (yū-glin′ɪ-dī). [Xylophitidæ].

Family Cerophytidae (ser″o-fai′tɪ-dī). Two kinds. [Often in Elateridæ].

Family Cebrionidae (seb″rɪ-ən′ɪ-dī). Eleven kinds; south and and west. [Often in Elateridae].

Family Platoceridae (plat″o-ser′ɪ-dī). Few kinds. [Often in Elateridae].

Family Rhipiceridae (rip″ɪ-ser′ɪ-dī). Six kinds.

Family **ELATERIDAE** (ī″lə-ter′ɪdī). Click-beetles. Abundant. [Often includes Cerophytidae, Cebrionidae, Platoceridae, Eucnemidae].

Family Eucnemidae (yūk-nī′mɪ-dī). [Melasidae. Often in Elateridae].

Family Throscidae (thros′ɪ-dī).

Family **BUPRESTIDAE** (biū-pres′tɪ-dī). Metallic wood-borers or buprestids. Common.

Family Psephenidae (sə-fī′nɪ-dī). Water-pennies. In swift streams. Four kinds. [Often in Parnidae].

Family Dryopidae (drai-ep′ɪ-dī). Parnids. In swift streams. [Parnidae].

Family Elmidae (el′mɪ-dī). In swift streams. [Helmidae; often in Parnidae].

Family Heteroceridae (het″ə-ro-ser′ɪ-dī). Heterocerids. Burrowing in mud-flats.

Family *Georyssidae* (jī″o-ris′ɪ-dī).

Family *Dascillidae* (də-sil′ɪ-dī).

Family *Helodidae* (hə-lō′dɪ-dī). Few kinds. [Often in Dascyllidae].

Family *Chelonariidae* (kel″o-nə-rī′ɪ-dī). One kind; Florida.

Family Dermestidae (dər-mes′tɪ-dī). Dermestids. On flowers, carrion, clothing and in insect collections. Common.

Family *Byrrhidae* (bīr′ɪ-dī). Pill-beetles. Scarce, and very small.

Family *Rhysodidae* (rɪ-sod′ɪ-dī). Four kinds.

Family Ostomidae (es-tom′ɪ-dī). [Trogositidae, Temnochilidae].

Family Nitidulidae (nit″ɪ-diū′lɪ-dī). Sap-beetles. About decaying fruit and sap.

Family *Rhizophagidae* (rai″zo-fag′ɪ-dī). Fourteen kinds. [Often in Nitidulidae].

Family *Monotomidae* (mo-no-tom′ɪ-dī). Few. [Often in Ostomidae].

Family Cucujidae (kiū-kiū′jɪ-dī). Cucujids. Under bark.

Family Erotylidae (er″o-til′ɪ-dī). Erotylids. Some large and brightly colored.

Family *Derodontidae* (de-ro-don′tɪ-dī). Five kinds. [Often in Cleridae].

Family *Cryptophagidae* (krip″to-fag′ɪ-dī). Small; in fungi.

Family *Mycetophagidae* (mɪ-set″o-fag′ɪ-dī). Small; in fungi; under bark.

Family *Colydiidae* (kō″lɪ-dī′ɪ-dī). Small; in fungi; under bark.

Family *Murmidiidae* (mər″mɪ-dī′ɪ-dī). Five kinds. [Often in Colydiidae].

Family *Monoedidae* (mo-nī′dɪ-dī). One kind; Florida.

Family *Lathridiidae* (lath″rɪ-dī′ɪ-dī).

Family *Mycetaeidae* (mai″sə-tī′ɪ-dī). Four kinds. [Often in Endomychidae].

Family Endomychidae (en″do-mik′ɪ-dī). Small, bright colored fungus beetles.

Family *Phalacridae* (f -lak′rɪ-dī). Small; on flowers under bark.

Family **Coccinellidae** (kok″sɪ-nel′ɪ-dī). Lady-bugs. Common on plants.

Family Alleculidae (al″ə-kiū′lɪ-dī). [Cistelidæ].

Family **TENEBRIONIDAE** (tə-nī″brɪ-ən′ɪd-ī). Darkling-beetles and pinacate-bugs. Common in dead wood, under bark, and under boards and stones, especially in the west.

Family Lagriidae (la-grī′ɪ-dī). Lagriids. A few kinds of large beetles; under bark or on leaves.

Family *Monommidae* (mo-nəm′ɪ-dī).

Family Melandryidae (mel″ən-drai′ɪ-dī).

Family *Ptinidae* (tin′ɪ-dī). Death-watch beetles. Small. Scarce. [Often includes Anobiidae, Bostrichidae and Lyctidae].

Family *Anobiidae* (an″o-bī′ɪ-dī). [Often in Ptinidae].

Family Bostrichidae (bəs-trik′ɪ-dī). [Often in Ptinidae].

Family Lyctidae (lik′tɪ-dī). Powder-post beetles. In dead wood. [Often in Ptinidae].

Family *Sphindidae* (sfin′dɪ-dī). Five kinds.

Family *Cisidae* (sis′ɪ-dī). Under bark and in fungus; minute, few. [Ciidæ].

Family **SCARABAEIDAE** (skar″əb-ī′ɪ-dī). Very many; common.

Family Trogidae (trō′gɪ-dī). [Often included in Scarabæidae].

Family **Lucanidae** (lu-kan′ɪ-dī). Stag-beetles. Large; not many kinds.

Family **Passalidae** (pə-sal′ɪ-dī). The Passalus. Large black beetles, in very rotten wood.

Family **CERAMBYCIDAE** (ser″am-bis′ɪ-dī). Longhorned beetles. Common, large, many kinds.

Family **CHRYSOMELIDAE** (krai″so-mel′ɪ-dī). Leaf-beetles. Very many kinds, brightly colored, on leaves.

Family Mylabridae (mai-lab′rɪ-dī). Bean-weevils; common. [Bruchidae].

Family *Brentidae* (bren′tɪ-dī). Brenthids. Scarce, slender beetles about or under bark.

Family Platystomidae (plat″ɪ-stəm′ɪ-dī). [Anthribidae].

Family *Belidae* (bel′ɪ-dī). One kind. Florida to Texas. [Often in Curculionidae].

Family **CURCULIONIDAE** (kər-kiū″lɪ-ən′ɪ-dī). Weevils or snout-beetles. Very many kinds; abundant.

Family Platypidae (pla-tip′ɪ-dī). Bark-beetles. [Platypodidae. Often in Scolytidae].

Family **Scolytidae** (skō-lit′ɪd-ī). Bark-beetles. Small, numerous. [Ipidae; often includes Platypidae].

Order *Strepsiptera* (strep-sip′tə-rə). Minute, rare, parasitic insects.

Family *Stylopidae* (stai-lep′ɪ-dī). Appea as little bunches between abdominal segments of paper-wasps and also other wasps and bees.

Order Mecoptera (mɪ-kəp′tə-rə). Scorpion-flies.

Family **Panorpidae** (pə-nōr′pɪ-dī). Common in damp woods. Very few kinds.

Order **Trichoptera** (trɪ-kəp′tə-rə). Caddice-flies. Larva are caddice worms and live under water; adults common resting on vegetation about streams and ponds. All are attracted to light in great numbers.

Family Hydroptilidae (hai″drop-til′ɪ-dī). Minut caddice-flies.

Family Hydropsychidae (hai″dro-sai′kɪ-d). Net-building caddice-flies.
Family Philopotomidae (fil″o-pə-təm′ɪ-dī). Net-building caddice-flies.
Family Polycentropidae (pel″ɪ-sen-trō′pɪ-dī). Net-building caddice-flies.
Family Limnophilidae (lim-no-fil′ɪ-dī). Caddice-flies.
Family Ryacophilidae (rai″ə-ko-fil′ɪ-dī). Caddice-flies.
Family Phryganeidae (frig″ə-nī′ɪ-dī). Caddice-flies.
Family Calamoceratidae (kal″ə-mo-sə-rat′ɪ-dī). Caddice-flies.
Family Sericostomatidae (ser″ɪ-kəs-təm′ɪ-dī). Caddice-fli s. [Sericostomatidae].
Family Leptoceridae (lep″to-ser′ɪ-dī). Caddice-flies.
Family Molanidae (mo-lan′ɪ-dī). Caddice-flies.
Family Odontoceridae (o-don″to-ser′ɪ-dī). Caddice-flies.

Order **LEPIDOPTERA** (lep″ɪ-dəp′tə-rə). Moths and butterflies.

MOTHS

Family *Micropterygidae* (mai-krəp″tə-rij′ɪ-dī). Very ra·e and small; few.
Family *Eriocraniidae* (er″ɪ-o-krə-nī′ɪ-dī). Very rare and small, few kinds.
Family Hepialidae (hep″ɪ-al′ɪ-dī). Swifts. Rare but large moths.
Family *Incurvariidae* (in-kūr″və-rī′ɪ-dī). Very small moths. [Adelidae].
Family *Nepticulidae* (nep″tɪ-kiū″lɪ-dī.) Very small moths; larvae leaf-miners. [Adelidae].
Family Cossidae (kəs′ɪ-dī). Carpenter-moths. Not common, some large.
Family Pyromorphidae (pai″-ro-mēr′fɪ-dī). Smoky moths. Few kinds but some common. [Zygaenidae].
Family *Dalceridae* (dal-ser′ɪ-dī.) Dalcerids. One kind; Arizona.
Family *Megalopygidae* (meg″ə-lo-pij′ɪ-dī.). Flannel-moths. Five kinds; not common.
Family Eucleidae (yū-klī′ɪ-dī). Slug-caterpillar moths. [Cochlidiidae].
Family *Epipyropidae* (ep″ɪ-pai-rō′pɪ-dī.) Epipyropids. One kind; New Mexico.

The following families are all very small moths, not easily distinguishable by the beginner, and the species are difficult to name:

Acrolophidae (ak″ro-lef′ɪ-dī). *Tineidae* (tin-ī-ɪ-dī); Psychidae (sai′kɪ-dī), bag-worm moths; *Tischeriidae* (tis″kə- rī′ɪ-dī); *Lyonetiidae* (lai″o-nə-tī′ɪ-dī); *Opostegidae* (əp″əs-tej′ɪ-dī); *Oinophilidae* (əi″no-fil-ɪ-dī); *Gracilariidae* (gras″ɪ-lə-rī′ɪ-dī); *Coleophoridae* (kəl″ī-o-fē′rɪ-dī); *Elachistidae* (el″ə-kis′tɪ-dī); *Heliozelidae* (hī″lɪ-o-zel′ɪ-dī); *Douglasiidae* (dug″lə-sī′ɪ-dī); *Oecophoridae* (ī″-ko-fō′rɪ-dī); *Ethmiidae* (eth-mī′ɪ-dī); *Stenomidae* (ste-nəm′ɪ-dī); *Gelechiidae* (jī″lɪ-kī′ɪ-dī); *Blastobasidae* (blas″to-bē′sɪ-dī); *Cosmopterygidae* (kəs-məp″te-rij′ɪ-dī);

• *Scythrididae* (sith-rid′ɪ-dī); *Y'ponomeutidae* (ɪ-pŏn″o-miū″-ti-dī); *Plutellidae* (plū-tel′ɪ-dī); *Glyphipterygidae* (gli-fip″tə-rij′ɪ-dī); *Heliodinidae* (hī″li-o-din′ɪ-dī); Aegeriidae (ī″jə-rī′ɪ-dī), clear-wing moths, [Sesiidae]; *Olethreutidae* (ō″lə-thrū′tɪ-dī); *Tortricidae* (tōr-tris′ɪ-dī); *Phaloniidae* (fal″o-nī′ɪ-dī); *Carposinidae* (kar″po-sin′-ɪ-dī); Pyralididae; (pai″rə-lid′ɪ-dī) [Pyralidæ]; *Pterophoridae* (te″-ro-fō′rɪ-dī). Plume-moths; *Orneodidae* (ōr″nī-ō′dɪ-dī), Feather-wing moths; Thyrididae (thai-rid′ɪ-dī); *Hyblaeidae* (hai-blī′i-dī).

Larger moths (macrolepīdoptera)

Family **SPHINGIDAE** (sfin′jɪ-dī). Sphinx moths; hawk-moths. Common.

Family **GEOMETRIDAE** (jī″o-met′rɪ-dī). Geometers, or measuring-worm moths.

Family Manidiidae (man″ɪ-dī′ɪ-dī). [Often included in Geometridae.]

Family *Dioptidae* (dai-ŏp′tɪ-dī). Dioptids. One kind; common in California.

Family **Notodontidae** (no-to-dŏn′tɪ-dī). The prominents.

Family Liparidae (lɪ-par′ɪ-dī). Tussock-moths. Few species; common. [Lymantriidae].

Family **NOCTUIDAE** (nŏk-tū′ɪ-dī). Noctuids. An enormous family of very common moths. [Includes Hypenidae].

Family Agaristidae (ag″ə-ris′-tɪ-dī). Agaristids. Day fliers.

Family Pericopidae (pɪ″ri-kō′pɪ-dī). Pericopids.

Family **Arctiidae** (ark-tī′ɪ-dī). Tiger-moths. [Includes Lithosiidae and Nolidae].

Family Euchromiidae (yū″kro-mī′ɪ-dī). Euchromids. [Amatidae or Syntomidae].

Family Eupterotidae (yūp″tə-rŏ′tɪ-dī.) Eupterotids.

Family Epiplemidae (ep″ɪ-plī′mɪ-dī). Epiplemids. Four kinds

Family Thyatiridae (thai″ə-tai′rɪ-dī). Thyatirids. Very few; common.

Family *Drepanidae* (drə-pan′ɪ-dī). Hook-tip moths. [Platypterygidae].

Family Lacosomidae (lak″o-sŏm′ɪ-dī). Lacosomids. Three kinds; not uncommon.

Family Citheroniidae (sith″ə-ro-nī′ɪ-dī). Royal moths. [Ceratocampidae].

Family **Saturniidae** (sat″ur-nī′ɪ-dī). Giant silk-worm moths.

Family *Bombycidae* (bŏm-bis′ɪ-dī). Silk-worm moth. Domesticated only.

Family Lasiocampidae (lē″sɪ-o-kam′pɪ-dī). Lasiocampids. Few kinds; common; include tent-caterpillars.

BUTTERFLIES

Family *Megathymidae* (meg″ə-thai′mɪ-dī). Giant skippers. Rare, south and south-west; few kinds; bore in Yucca.

Family **HESPERIIDAE** (hes″pe-rī′ɪ-dī). Skippers. Common.

Family **Papilionidae** (pə-pil″ɪ-ŏn′ɪ-dī). Swallow-tails and parnassians.

Family **Pieridae** (pī-er′ɪ-dī). The whites, sulphurs, and orange-tips.

Family **Nymphalidae** (nim-fal′ɪ-dī). The four-footed butterflies. Common.

Family Riodinidae (rī″o-din′ɪ-dī). The metal-marks. Scarce; few kinds; south and west. [Erycinidae].

Family **Lycaenidae** (lai-sen′ɪ-dī). The hair-streaks, coppers, and blues, or gossamer-winged butterflies.

Order **DIPTERA** (dip′tə-rə). Flies.

Family *Tanyderidae* (tan″ɪ-der′ɪ-dī). The primitive crane-flies. One extremely rare kind. [Often included in Tipulidae].

Family Ptychopteridae (tai″kəp-ter′ɪ-dī). Phantom crane-fly family. Three kinds, common. [Often included in Tipulidae].

Family Ryphidae (rai′fɪ-dī). So-called false crane-flies. Very few kinds.

Family **TIPULIDAE** (tɪ-piū′li″-dī). Crane-flies.

Family *Dixidae* (dix′ɪ-dī). Dixa midges. Rare; few kinds.

Family Psychodidae (sai-kō′dɪ-dī). Moth-like flies. Small; common in wet places.

Family **CHIRONOMIDAE** (kai″ro-nem′ɪ-dī). Midges. Very abundant, delicate mosquito-like flies, often in swarms. A great many kinds.

Family **Culicidae** (kiū-lis′ɪ-dī). Mosquitos.

Family Mycetophilidae (mai-set″o-fil′ɪ-dī). Fungous-gnats. Numerous.

Family *Cecidomyiidae* (ses″ɪ-do-mai-ī′ɪ-dī). Gall-gnats. Very small but abundant; many kinds. [Itonididae].

Family Bibionidae (bib″ɪ-ən′ɪ-dī). March-flies. Few kinds; common.

Family *Scatopsidae* (skə-təp′sɪ-dī). Scatopsids.

Family Simuliidae (sim″yu-lī′ɪ-dī). Black-flies. Common especially in the northeast; not many kinds.

Family *Blepharoceridae* (blef″ə-ro-ser′ɪ-dī). Net-winged midges. Few kinds; rare.

Family *Orphnephilidae* (ōrf″nə-fil′ɪ-dī). The solitary midge. One rare kind.

Family **Tabanidae** (tə-ban′ɪ-dī). Horse-flies. Common.

Family Stratiomyiidae (strat″ɪ-o-mai-ī′ɪ-dī). Soldier-flies. Common.

Family *Xylomyiidae* (zai″lo-mai-ī′ɪ-dī). Uncommon; few kinds [In Leptidaē].

Family *Xylophagidae*. (zai″lo-faj′ɪ-dī). Uncommon; few kinds. [In Leptidaē].

Family *Coenomyiidae* (sī″no-mai-ī′ɪ-dī). Rare; few kinds. [In Leptidæ].

Family **Rhagionidae** (rag″ɪ-ən′ɪ-dī). Common. [Leptidae].

Family *Nemestrinidae* (nem″ə-strin′ɪ-dī). Tangle-vein flies. Very rare; western.

Family *Acroceridae* (ak′ro-ser′ɪ-dī). Rare; few kinds. [Cyrtidae].

Family **BOMBYLIIDAE** (bəm″bɪ-lī′ɪ-dī). Bee-flies. Common; many kinds.

Family Therevidae (thə-rev′ɪ-dī). Stiletto-flies. Scarce; few kinds.

Family *Scenopinidae* (sken″o-pī′nɪ-dī). Window-flies. Scarce; few kinds.

Family **Asilidae** (ə-sil′ɪ-dī). Robber-flies. Large, common flies.

Family Mydaidae (mai-dē′ɪ-dī). Mydas-flies. Very large flies; common in south; few kinds.

Family *Apioceridae* (ap″ɪ-o-ser′i-dī). Apiocerids. Very rare; western.

Family **Dolichopodidae** (dɔl″ɪ-ko-pō′dɪ-dī). Long-legged flies. Very common about streams and damp vegetation; many kinds; difficult to name.

Family Empididae (em-pid′ɪ-dī). Dance-flies. Common about streams.

Family *Lonchopteridae* (lən″kep-ter′ɪ-dī). Spear-wings. Small; few kinds.

Family *Phoridae* (fōr′ɪ-dī). Minute flies; common.

Family *Platypezidae* (plat″ɪ-pī′zi-dī). Flat-footed flies. Few kinds; scarce.

Family Pipunculidae (pip′uŋ-kiū′lɪ-dī). Big-eyed flies. Uncommon; few kinds.

Family **Syrphidae** (sɪr′-fɪ-dī). Syrphus-flies. Very common; very many kinds.

Family Conopidae (ko-nep′ɪ-dī). Thick-headed flies; common on flowers.

The following families are mostly composed of small flies; known collectively as acalyptrate muscids. Many of these families are difficult to distinguish, and the species are difficult to name:

Cordyluridae (kōr″dɪ-lu′rɪ-dī), dung-flies, [Scatophagidæ]; *Clusiidae* (klu-sī′ɪ-dī), [Heteroneuridæ]; Helomyzidae (hī″lo-mai′zɪ-dī); *Borboridae* (bōr-bō′rɪ-dī); *Phycodromidae* (fai″ko-drō′mɪ-dī); Sciomyzidae (sai″o-mai′zi-dī), [Tetanoceridae]; Sapromyzidae (sap″ro-mai′zɪ-dī); *Lonchaeidae* (lən-kī′ɪ-dī), [often included in Sapromyzidae]; Ortalidae (ōr-tal′ɪ-dī); Trypetidae (trai-pīt′ɪ-dī); Micropezidae (mai″kro-pī-zɪ-dī); *Tanypezidae* (tan″ɪ-pī′zɪ-dī), [often in Micropezidæ]; Sepsidae (sīp′sɪ-dī); *Piophilidae* (pai″-o-fil′ɪ-dī), cheese-maggot flies, [often in Sepsidae]. *Psilidae* (sil′ɪ-dī); *Diopsidae* (dai-ep′sɪ-dī); Ephydridae (e-fid′rɪ-dī); *Chloropidae* (klo-rep′ɪ-dī), [includes Oscinidae]; *Asteiidae* (as-tī′ɪ-dī), [usually included in Drosophilidae]; Drosophilidae (drɔs″o-fī′lɪ-dī); *Geomyzidae* (jī″o-mai′zɪ-dī); *Agromyzidae* (ag″ro-maī′zɪ-dī); *Milichiidae* (mi″lɪ-chī′ɪ-dī), [often included in Agromyzidae]. *Ochthiphilidae* (ɔk″thɪ-fil′ɪ-dī), [often in Agromyzidae].

Most of the succeeding nine are large families of very common flies, the house-fly and its allies; but they are difficult for the beginner to distinguish, or to name the kinds.

Family **Anthomyiidae** (an″thō-mai-ī′ɪ-dī). Common; many kinds.

Family *Gastrophilidae* (gas″tro-fil′ɪ-dī). Horse bot-flies. Adults very rare. [Included in Oestridae].

Family *Oestridae* (īs′trɪ-dī). Bot-flies. Adults very rare.

Family *Phasiidae* (fə-sī′ɪ-dī). Phasiids. Few kinds.
Family *Megaprosopidae* (meg″ə-pro-sō′pĭdɪ).
Family **Calliphoridae** (′kal″ɪ-fō′rɪ-dī). The blow-fly family.
Family Sarcophagidae (sär″ko-faj′ɪ-dī). Common.
Family **Tachinidae** (tə-kī′nɪ-dī). Tachina-flies. Very common parasitic flies.
Family **Muscidae** (mus′ĭ-dī). Muscids. The house-fly and its allies. Very common.
Family *Hippoboscidae* (hip″o-bos′ɪ-dī). Louse-flies. Flattened flies in feathers of owls and other birds.
Family *Streblidae* (strī′blɪ-dī). Bat-ticks. Rare.
Family *Nycteribiidae* (nik″tə-rɪ-bī′ɪ-dī). Bat-ticks. Rare.
Family *Braulidae* (brē′lɪ-dī). Bee-lice. Very rare.

Order Siphonaptera (sai″fo-nap′tə-rə). Fleas.
Families *Ischnopsyllidae* (isk″no-sil′ɪ-dī), bat-fleas; *Leptopsyllidae* (lep′to-sil′ɪ-dī); *Ceratophyllidae* (sə-rat″o-fil′ɪ-dī); Pulicidae (piū-lis′ɪ-dī), the human-flea family; *Echidnophagidae* (ə-kid″no-faj′ɪ-dī).

Order **HYMENOPTERA** (hai″mə-nop′tə-rə). Wasps, bees, ants, ichneumon-wasps, gall-wasps, saw-flies.
Family *Xyelidae* (zai-el′ɪ-dī). Xyelids.
Family Pamphiliidae (pam″fɪ-lī′ɪ-dī). Pamphiliids. [Lydidae].
Family Siricidae (sai-ris′ɪ-dī). Horn-tails. Very large and brightly colored.
Family Xiphydriidae (zif″ɪ-drī′ɪ-dī). Xiphydriids.
Family Cephidae (sī′fɪ-dī). Cephids.
Family Cimbicidae (sim-bis′ɪ-dī). The willow saw-flies.
Family Argidae (är′jɪ-dī). Saw-flies. Few kinds.
Family **TENTHREDINIDAE** (ten″thrə-din′ɪ-dī). Saw-flies. Very many kinds; common.
Family *Oryssidae* (o-ris′ɪ-dī). Very rare; few kinds.
Family **BRACONIDAE** (brə-kon′ɪ-dī). Braconids. Very many kinds; abundant.
Family **ICHNEUMONIDAE** (ik′niū-mon′ɪ-dī). Ichneumon-wasps. Very many kinds; very abundant.
Family *Trigonalidae* (trig″o-nal′ɪ-dī). Trigonalids. Rare; very few kinds.
Family *Aulacidae* (au-lak′ɪ-dī). Aulacids. Rare; few kinds [In Evaniidae].
Family *Stephanidae* (stī-van′ɪ-dī). Stephanids. Very rare; very few kinds; large.
Family Foenidae (fī′nɪ-dī). On flowers; few kinds. [In Evaniidae].
Family *Roproniidae* (rop″ro-nī′ɪ-dī). Very rare; small; very few kinds.
Family *Heloridae* (hī-lor′ɪ-dī). Rare; very few kinds; small.
Family *Vanhorniidae* (van″hōr-nī′ɪ-dī). Very rare; one kind; north-east.
Family *Belytidae* (bə-lit′ɪ-dī). Minute; not rare.
Family *Serphidae* (sūr′fɪ-dī). Mostly minute, not rare. [Proctotrypidae].
Family *Scelionidae* (skī″lɪ-on′ɪ-dī). Very minute insects.
Family *Platygasteridae* (plat″ɪ-gas-ter′ɪ-dī). Very minute.

Family Pelecinidae (pel″ə-sī′nɪ-dī). The pelecinus. One common, black very slender wasp.
Family Cynipidae (sai-nip′ɪ-dī). Gall-wasps. Very common; many kinds; all very small.
Family **Chalcididae** (kal-sid′ɪ-dī). Chalcid-flies; an enormous number of minute, mostly metallic species; exceedingly common.
Family Evaniidae (ev″ə-nī′ɪ-dī). Ensign-flies. [Some authors include Foenīdae and Aulacidae].
Family **Psammocharidae** (sam″o-kar′ɪ-dī). Spider-hunting wasps. Common; many kinds.
Family *Cleptidae* (klep′tɪ-dī). Rare; few kinds; metallic.
Family Chrysididae (krai-sid′ɪ-dī). Cuckoo-waspe. Not rare; bee-like, but brilliant metallic green or copper or blue; fly about fences and beams.
Family *Embolemidae* (em″bo-lem′ɪ-dī). One or two extremely rare, minute kinds.
Family *Sapygidae* (sə-pij′ɪ-dī). Rare wasps; few kinds.
Family *Thynnidae* (thin′ɪ-dī). Two extremely rare, western, ant-like kinds.
Family **Tiphiidae** (tɪ-fī′ɪ-dī). Common, visiting flowers, some ant-like, on ground. [Sometimes partly included in Scoliidae; includes Myrmosidae].
Family **Mutillidae** (miū-til′ɪ-dī). Velvet-ants. Common in south and west and on Atlantic coast; many kinds.
Family **Scoliidae** (sko-lī′ɪ-dī). Scoliids. Common, large brightly colored wasps, visit flowers.
Family **FORMICIDAE** (fēr-mis′ɪ-dī). Ants.
Family *Bethylidae* (bə-thil′ɪ-dī). Very small, scarce wasps; often wingless.
Family *Rhopalosomidae* (rō″pə-lo-sō′mɪ-dī). One extremely rare, night flying wasp; south-eastern.
Family **VESPIDAE** (ves′pɪ-dī). True wasps. Very common; very many kinds. [Includes Eumenidae and Masaridae].
Family *Ampulicidae* (am″piū-lis′ɪ-dī). Two extremely rare, southeastern kinds.
Family *Dryinidae* (drai-īn′ɪ-dī). Small wasps which parasitize tree-hoppers.
Family **SPHECIDAE** (sfes′ɪ-dī). Sphecid-wasps. Very many kinds, nesting in sand, banks, posts and twigs. Very common. [Includes Trypoxylonidae, Crabronidae, Oxybelidae, Philanthidae, Mellinidae, Psenidae, Bembecidae, Nyssonidae, Gorytidae, Pemphredonidae, Nitelidae, Astatidae].
Family **Hylaeidae** (hai-lī′ɪ-dī). Solitary bees. [Prosopidae; includes Colletidae]. Very common; on flowers.
Family **ANDRENIDAE** (an-drīn′ɪ-dī). Solitary bees. Very common; very many kinds; on flowers. [Includes Panurgidae, Anthophoridae, Macropidae, Ceratinidae, Xylocopidae].
Family **Megachilidae** (meg″e-kai′lɪ-dī). The leaf-cutter bees. [Includes Stelidae].
Family **Bombidae** (bəm-bɪ-dī). Bumblebees. [Bremidae].
Family Apidae (ap′ɪ-dī). Honey-bees.

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

P9-ADI-966